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AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

JULY, 1836.

Practical and Theoretical Mechanics.

Experiments on the resistance of sand to motion through tubes, with especial reference to its use in the blasting of rocks, made at Fort Adams, Newport harbour, under the direction of Col. Totten. By Lieut. T. S. Brown, of the Corps of Engineers.*

TO THE COMMITTEE ON PUBLICATIONS.

Gentlemen: The great quantity of rock excavation required at Fort Adams, Newport, R. I. created, at an early period of the operations, an earnest desire, on the part of the officers of engineers charged with the construction of that work, to devise some method of loading and securing the drill holes which would be less dangerous to the workmen than the one which had been usually employed. For this purpose resort was had to the use of clean dry sand in the manner which will be hereafter described, it being understood that that expedient had been successfully tried at other places. It was found, however, that great prejudices existed among the workmen on this subject, and that from their belief of the inefficiency of the new method, they required to be constantly watched, to prevent them

* We are compelled to divide this interesting paper. The first part, consisting mainly of a translation of the essay of M. H. Burnand, is now given, and the experiments which form the more important part of the paper, will follow in the next number.

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from jeoparding their own safety, by returning to the old practice of filling the holes with fragments of stones and bricks, driven in with violence above the powder. It appeared to be important that the doubts of the workmen should be put at rest, and that several practical questions connected with the use of sand, in blasting, should be solved, and it was the intention of Colonel Totten, the superintending engineer, that experiments should be made for these purposes. This intention was confirmed by the appearance, in the "Journal of the Royal Institution," and in the "American Journal of Science," of brief notices, of a paper describing some interesting experiments on the flow and pressure of sand, which had been made in Europe. I was accordingly directed to institute a series of trials, having for their object, to determine the degree and nature of the resistance offered by sand when it is attempted to force it through a tube by direct pressure, and it was intended, at the same time, to investigate, more thoroughly, some of the properties of this substance which were developed in the European experiments just mentioned.

The experiments made in consequence of these instructions were prosecuted at distant intervals of leisure during the years 1829 and 1830, but they were interrupted before all had been accomplished, which had been originally designed; nevertheless, the results obtained were interesting, and it is thought that a brief account of them may be acceptable to the readers of your Journal.

Having, subsequently to making the experiments, procured, through the kindness of my friend, Professor A. D. Bache, a copy, in French, of the original paper above referred to, which has been several times re-published in Europe, I have translated it at length, from the "Annales de Chimie et de Physique," vol. XL, page 159, and prefix the translation to the summary of my own investigations.

TRANSLATION.

Letter of M. Huber Burnand, to Professor Prevost, on the flow and pressure of sand.

[M. Huber Burnand, two years since, presented to the Society of Physics and Natural History of Geneva, an anemometer, in which the force and duration of the wind, were measured by the quantity of sand which escaped from a variable opening, proportioned in size to the force which it was proposed to measure. On this subject, M. Prevost proposed the following question. Does not the sand in its flow, correspond in a certain degree with a liquid, and is not its discharge in consequence, more rapid, as the head in the vessel which contains it is greater? He indicated at the same time, the further researches which might be made as to the mode of action of the sand, in regard to the pressure which it exerts. Such is the origin and motive of the experiments submitted by M. Burnand to M. Prevost in this letter, which has been kindly communicated to us for publication.]

By preliminary trials, I ascertained that the two following precautions are necessary to obtain a tolerably regular flow of sand. First, it is indispensable that the sand should be sifted with the greatest care, but that it should not be as fine as flour. The sand used by founders would be too fine for this purpose; its fall would be irregular and would be frequently interrupted without any assignable cause. If, instead of this, we take the sand used in making tiles, and carefully sift it through a cotton gauze, the holes of which are produced by a web, which presents thirty-eight threads

by forty-five in the space of one square inch, we shall find it to flow with the greatest facility. The second condition necessary to the uninterrupted flow of the sand, is that the opening should have a diameter of at least $\frac{1}{15}$ of an inch.

These first questions settled, I could proceed to the researches which I had in view. For this purpose, I had made two wooden boxes, one thirty-one inches high, with a bottom twelve inches square, and another forty-seven inches high, with a bottom only four inches square. They were open at the top, and provided at the bottom with four small boards, sliding in grooves disposed in the form of a cross, so as to permit the aperture to be widened or lengthened at pleasure. The slides were made thin, so that the flow should not be affected by the thickness of the wood, a circumstance the inconveniences of which, I had already discovered. These two boxes were raised on four legs, for the convenience of experimenting, and I procured an excellent stop watch to ensure accuracy in the results. The volumes were measured in a graduated glass tube, and I had also obtained a very sensible balance, with very exact metrical decimal weights. I must add that all my trials were repeated several times, and that I had acquired by long practice, such skill in these experiments, that an error of a quarter of a second in time, would have been detected in the results.

In the most delicate experiments, I introduced metallic slides graduated to $\frac{4}{100}$ths. of an inch, instead of the wooden ones: they were however, still by no means as exact as was desirable.

I shall divide my researches into two parts; those which have for their special object the flowing of sand, and those which refer more particularly to its pressure, as serving to explain the phenomena ascertained in relation to the first subject.

I. *The flow of Sand.*

1. The quantity of sand which flowed in a given time from a given opening, was absolutely the same, both by volume and weight, whatever the height of the sand in the box at the commencement of the experiment There were nevertheless, occasional variations, more or less, of two or three grammes.* They were caused, most frequently, by the difficulty of introducing and withdrawing, at the proper moment, the vessel which was used to receive the sand. The errors compensated for each other, and disappeared when quantities as great as from four to five hundred grammes were employed. Three minutes were ordinarily employed in an experiment. The quantities obtained during the consecutive ninety seconds, were weighed, and when the weights were equal we called them accurate.

The weights were placed together, and compared afterwards with others obtained in the same manner, with columns of sand of ten times the height. The results were always perfectly alike.

2. The quantity of sand flowing through a hole from $\frac{1}{8}$th. to $\frac{1}{15}$th. of an inch wide, was always in direct proportion to the length of the opening, a fact which is susceptible of very useful applications in several Philosophical instruments. But the least variation in the breadth of the opening, caused in the quantity of sand flowing out, an increase, which exceeded the simple ratio of the surfaces of the orifice, as far, at least, as I could judge with the imperfect means which were at my disposal.

3. The sand escaping through openings in the side of the box, flow-

*A *Gramme* is about 15½ grains. Tr.

ed with the same velocity whatever the height of the column was. But if the holes were placed horizontally, and had not a vertical dimension about equal to the thickness of the board, not a single grain of sand fell from them, whatever its height in the box.

4. Sand poured into one branch of a tube bent twice at right angles, does not rise in the opposite branch as a liquid does; it only extends a very small distance from the elbow into the horizontal part.

5. Whatever may be the pressure to which sand contained in a box is subjected, it does not influence in any manner, the quantity which flows out through a given opening situated at the bottom of the box or in the sides. The experiment was made successively with masses of iron weighing from twenty-six to fifty-five pounds.

6. A graduated rod inserted perpendicularly in the top of the column of sand, and precisely in the direction of an opening below, descends in and with the sand without inclining in any direction, and with a motion nearly as uniform as that of a clock. A rod fifteen inches long, was made at pleasure to descend $\frac{4}{10}$ths. of an inch per minute or per second. An overshot wheel placed in the interior of the box, and provided with an index outside, also moved with astonishing regularity, but very slowly. If the rod, instead of being placed in the axis of motion, was placed nearer the sides of the box, it inclined with great uniformity, but at the same time descended and advanced towards the centre with a very slow motion. The velocity of this rod depends then, principally on its position in the sand, and next on the size of the orifice. The velocity is probably also proportional to the ratio which exists between the surface of the orifice and the horizontal section of the box, since it depends upon the quantity which flows out during each instant, compared with the whole quantity.

With more care and several modifications of the apparatus, it would probably be possible to produce more regularity than I have attained, in the progress of movable bodies, carried along by the friction of the sand.

I will remark in passing, that there probably does not exist any other natural force on the earth, which produces of itself a perfectly uniform movement, and which would not be altered by gravitation, by friction, or by the resistance of the air. We see that the height of the column has no influence on the velocity of motion of the sand, neither increasing nor diminishing it. As to friction, far from being an obstacle, it is itself the direct cause of the regularity and uniformity of the movement, as will be shown in the sequel of my experiments; and the resistance of the air in the interior of a column of sand in motion, must be very small indeed, since none of the grains fall freely. The hour glass, a time piece, which preceded all others, was thus founded on a much more philosophical basis than has been supposed, and I venture to flatter myself that my researches may be of some use to it, in its application to the arts and to science.

7. After having studied sand in motion, I examined its mode of action when distributed in heaps upon a plane.

For this purpose I began by placing isolated grains of sand on a movable plane, susceptible of being inclined at will; they hardly rolled until the plane was inclined at least, under an angle of thirty degrees, and some remained at an inclination of forty degrees, but beyond this none remained at rest. Sand never assumes a level of itself; the angle, or the angles under which it usually presents itself, after a part of its mass has crumbled, are

almost always between thirty and thirty-three degrees; it rarely maintains itself at thirty-five degrees.

In a well sifted heap, the inferior layers, themselves inclined at thirty degrees with the horizon, serve naturally as supports to the superior ones; but the greater part of the weight of these latter, is supported by the portion of the horizontal plane against which they terminate or abut. If we take away this portion of the horizontal plane or bottom, these outer layers immediately roll off, leaving those on which they rested, undisturbed and inclined under an angle of from thirty to thirty-three degrees. This explains why sand does not flow out of a horizontal opening, if the thickness of the body through which the opening is pierced, is equal to or greater than the height, or vertical dimension of the orifice. In this case the superior layers find points of support on the sides of the containing vessel, and an absolute obstacle in the inferior layers.

Is this property connected with the form of the grains of which the sand is composed? If they had more regularity we might conjecture so, but upon looking at them through a microscope, we see such a variety of figures and dimensions that it is impossible to admit this idea. The greater part of the grains are crystalline laminæ, white, flattened and variously terminated; other particles are grey, yellow, brown, &c. with such different forms that they cannot be arranged into distinct classes.

In order to decide whether the form was of any importance in the arrangement of the parts, I tried other substances besides sand, and found that peas or small shot, although with a little more difficulty in forming them into slopes, took nearly the same angle, and followed in all respects the same laws.

II. *Pressure of Sand and other Substances composed of Grains.*

1. An egg having been placed at the bottom of a box and covered with several inches of sand, the sand was loaded with a mass of iron weighing fifty-five pounds. The result was precisely what I had anticipated; the egg remained unbroken under the great weight which was placed above it.

I repeated this experiment, putting the sand in motion by means of an orifice at the bottom of the box. The result was the same, whether the egg was placed at the bottom or in the middle of the mass of sand.

These trials proved that the pressure excited by the mass of iron was deflected laterally by the interposition of the sand. They proved also, that a body placed in a mass of sand, is protected by it as it would be by a liquid, although the sand has a different kind of action from the liquid, on the sides of the vessel containing it.

These conclusions being somewhat paradoxical, I resolved to have recourse to more decisive proof.

2. I took a tube of glass open at both ends, and inserted it, vertically into a small horizontal tube of wood near one end, the other end of this horizontal tube being exactly fitted into a vertical cylindrical box $\frac{4}{10}$ths. of an inch in diameter and eight inches in height.

I filled this box with mercury, as if it had been the cistern of a barometer; the mercury naturally assumed its level in the vertical tube of glass. Its height in this tube was marked. I then adapted to the box, or cylindrical cistern, a large tin tube twenty-seven inches long, and one inch and one-third in diameter. I filled this large tube with sand, taking care to pour it in very slowly, so as not to agitate the mercury.

Here was a true barometer for measuring the weight of the sand; there

was an equal pressure of air on each side, so that apparently nothing prevented the equilibrium between the sand and the mercury. Although I had in part expected the result, I was surprised to see that the sand had added nothing to the weight of the mercury; the liquid kept its level to within $\frac{1}{12}$th. of an inch, a difference which was produced by an accidental shaking of the apparatus during the experiment; for having changed the place of the apparatus, the mercury resumed its level as before the experiment, and preserved it as long as I maintained this state of things.*

I afterwards took the sand from above the mercury; it had not penetrated into the liquid. I substituted in its place dried peas; the large tube was completely filled with them, their weight being more than three pounds. I added an iron weight of upwards of two pounds, and lastly a pressure of the hand as great as I durst apply without endangering the apparatus. The mercury kept its level in the glass tube; not rising $\frac{1}{24}$th. part of an inch. The apparatus remained several days on trial without any other result. Thus the mercury had not been acted on by the weight of the sand, nor by that of the peas.

This absence of pressure on the bottom of a vessel was still better proved by the following experiments.

3. I took the same tube of tin and suspended it from a very sensible balance; I counterbalanced it exactly, and arranged it so that it reached nearly to the floor. I placed on the floor itself, a small solid cylinder of wood, about two inches high, and a little less in diameter than the large tube, so that the tube inclosed the cylinder, and could play freely in a vertical direction. As the tube was perfectly equipoised, and suspended to the arm of the balance vertically above the small solid cylinder, it moved upwards and downwards along this latter without any sensible friction.

I next weighed out a quantity of dried peas and introduced them into the large tin tube. It lost its mobility instantly, as if it had become more heavy, notwithstanding that it had no bottom, and the peas had a solid support on the top of the cylinder of wood.

I afterwards put into the opposite dish of the balance a certain number of grammes successively, until the dish descended, when the tube separated from the cylinder, allowing the escape of the peas which it had contained.

The weight required to raise the tube from the top of the cylinder was, within a very few grammes, equal to the weight of dried peas which I had poured into the tube; the difference was not more than twenty grammes, whilst the weight of the peas was more than three and a quarter pounds. The tube, therefore, appeared to be loaded with all the weight of the peas to which it gave its support.

The experiment repeated with different quantities and with additional weights always succeeded, and often within eight or ten grammes.

But it might be still objected that the lower cylinder had in some way supported the weight of the column. I therefore made the inverse experiment.

4 and 5. In this experiment I fastened the tube by two cords to two supports laterally, and suspended the small cylinder from the dish of the balance, in such a way that being equipoised before hand, it was introduced freely half an inch into the tin tube, and by the least additional weight it fell and permitted the escape of its load.

* The experiment would have been more simply made with a tube bent like a syphon with parallel branches; but M. Burnand had none at his disposal.

I then poured about three and a quarter pounds of peas into the tube, and finding that the wooden cylinder which was perfectly free, did not fall, I added a weight of two and a quarter pounds and other weights, without even moving it. It might still be objected, however, that the small cylinder adhered to the sides of the tin tube. To answer this objection, and to render this experiment more striking, I removed the cylinder, and made use of a simple disk of wood of greater diameter than the tube, and supported against its bottom by placing in the balance just weight enough to keep the two in contact. This weight was commonly from ten to twelve grammes.

I then filled the large tube with from three to four pounds of sand, and placed additional weights upon the top of the column, nevertheless the disk, retained by the small counterpoise of ten or twelve grammes, did not move. If this same weight of a few grammes had been laid on that part of the disk which projected beyond the tube, it would without doubt have caused it to fall, for it alone retained the disk in its place. A slight touch of the finger, caused the sand to pour from the lower end of the tube, and fall into a basin placed below to receive it. The disk was therefore instrumental in retaining the sand, but did not sustain the weight of it, which was all transferred to the sides of the large tin tube. Ten grammes would have caused this disk to separate from the tube, and since it remained adhering to it, the disk was not loaded with the mass of the sand.

6. To remove all kind of doubt, I gave up the use of the balance, and placing a tub of water near the large fixed tube, floated the disk of wood on the water with the smooth side upwards; I then brought the end of the tube down upon the disk, and poured water into the tub. The disk was pressed by the weight of the water against the end of the tube. I next filled the tube with dried peas but the disk did not move. It, however, was essential in retaining the peas, which without it would have fallen through the tube; but the peas did not press upon it, since a very small force would have sufficed to make them fall from the tube and thus derange the whole apparatus.

7. Leaving every thing in the same condition, I poured water into the large tube; it was kept there with the peas, for a considerable time, until an unforseen motion produced by the compressed air, which was disengaged from the bottom of the tube, caused the machine to incline. The peas then escaped into the tub, and the water flowed out at the same time. The same trial was made with sand; a considerable quantity of water was poured on the sand, fully impregnating it, and during a very long time it was supported without flowing out.

In another trial made a little differently, the sand took such a consistence with the water that it caused much trouble to get them out of the tube, which therefore entirely supported the weight of the sand and of the water, together with the force necessary to expel them.

8. We can make these experiments by simply causing the large tube to rest on a small conical heap of sand, whilst it is still suspended from the disk of the balance. The sand does not escape when the weight put into the other disk is nearly equivalent to the weight of the tube and its contents.

The same trials succeeded with grain: I have repeated them with shot with equal success, although this has a very great weight. They may also be made with a simple roll of paper tied with two small strings; they are then much more striking as the weight acquired by the paper tube contrasts better with its original lightness.

9. I have repeated these experiments with a tin tube widened at the bottom and much larger than the great tube; the result was the same, although there can be no doubt that there is a limit beyond which the sand would receive no further support from the sides of the tube. This will be the case when the inclination of these sides to a horizontal plane is the same as the slope assumed by sand in a heap, that is to say about thirty degrees. I have also repeated several of these trials with a cylindrical tube four inches in diameter, with the same success.

10. From all that I had seen I presumed that it would be very difficult to force sand through a tube even by means of a direct pressure. I made the trial in the following manner. I filled the great tube with sand and laid it in a horizontal position, and with a cylinder of wood, several feet in length, and a little less in diameter than the tube, endeavored to force out the sand at one end by pressing it at the other, but without success. It appeared to me that it would be easier to burst the tube than to move the sand a single inch. The tube being inclined to the horizon about twenty degrees, and the effect being thus aided by the weight of the body, the sand still could not be expelled; the same result followed in inclining the tube in the contrary direction. This explains very clearly why a blast confined with sand is as effectual as any other.

Ynerduv, 15th January 1829.

P. S. If in the experiment in section 2, under the head of the pressure of sand, we pour water into the tube which contains the peas, the mercury will rise in the glass tube one-fourteenth of the height of the water; a proportion which corresponds with that of the specific gravities of those liquids. The water acts as usual, but the peas exert no pressure.

2nd. There is another way of making the experiment with the tube which is within the reach of every body. Procure a tin tube an inch in diameter and as long as is desired, open at both ends. Take a sheet of fine paper and apply it against the end of the tube pressing up the edges with the hand so as to make it take its form; then moisten the edges of the paper with water and cause them to adhere to the sides of the tube. Place the end on a table and fill the tube with sand. Raise it with care, and notwithstanding the slight adherence of the paper, the sand will be sustained while the tube is freely moved about.

3rd. It would be desirable to place a vessel of sand provided with an orifice for its escape, under an air pump, in order to determine whether the velocity would be affected by its flowing in a vacuum.

[*Biblioth. Univ. XL*, 22.

(TO BE CONTINUED.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Manufacture of Military Projectiles, Translated from the French of F. J. Culmann, Chef d'escadron d'artillerie, &c. &c. by ALFRED MORDECAI, *Captain United States Ordnance Department.*

The principal objects of this article are to point out certain faults in the manufacture of projectiles, and to indicate the means of giving them an even surface, an accurate eye, a thin seam, exact dimensions and perfect sphericity: on these points no detail will be neglected, but we shall not dwell on the description of processes which are well known in founderies.

Of the Iron used for casting Projectiles.

The kind of cast iron of which the best hollow projectiles are made is that obtained from very fusible ore, reduced with charcoal in furnaces of small elevation, at a medium heat, or by working the furnace in such a manner that the metal may be well mixed, inclining more towards a lamellar white metal than to grey, so that the laminæ, marked with greyish spots, may still be distinguished in it. The surface of a projectile made of this metal, which is very liquid, is perfectly smooth and free from flaws and holes, which is not the case with those made of grey metal, particularly of that which does not run freely. Metal inclining to white cannot be obtained with certainty from refractory ores, nor even from fusible ores if reduced with coke, or in furnaces of a certain height: this metal is moreover unsuitable for the manufacture of other articles, even for that of solid projectiles. In general, therefore the production of it is not desirable, and when accidentally obtained, it can seldom be used, because the projectiles made from it are too small; white cast iron, or that which inclines to white, shrinks more in cooling, or else at the instant of becoming solid, it expands less than the grey metal. In order to employ it usefully, therefore, the dimensions of the mould must be adapted to the properties of this kind of iron. It may also be doubted whether this brittle iron presents a sufficient resistance to the force of the powder, to prevent the projectile from being broken in leaving the piece, and to enable it to give, in certain cases, large fragments moving with sufficient velocity. It is used however in one of the iron districts of France, and with excellent results.

For the casting of hollow projectiles it is of little consequence whether the metal be good or bad, with reference to the quality of the fine iron obtained from it. It may even be said that the metal which produces a brittle iron, and which is generally very liquid, is better suited for this purpose than that which produces tough iron, provided that its bad quality does not proceed from the presence of too much silex, which would cause cracks and rents.

Castings which are to be very dense and solid, and of a medium thickness should not be made from the crude iron of coke furnaces, when it contains a large proportion of earthy minerals: a portion of the latter is thrown out when the metal is cooled by exposure to the air, and this causes flaws in the interior resembling rents; and when this metal is cooled without exposure to the air, interior crystallizations are formed, which also produce flaws. These phenomena, arising from unequal cooling, seldom occur if the castings are either very large or very thin; in the former case the metal being very liquid, heats the mould and then cools nearly at the same time throughout the mass; in the latter, the cooling is almost instantaneous.

Metal which does not contain a large proportion of earthy minerals has no tendency to form these crystallizations; an appearance which resembles them at first sight is sometimes produced by laminæ of graphite which in the cooling of the metal, collect in the interior of the mass. Crystallizations are frequently met with in the white grained metal, (when it is not produced by an overcharge of ore,) as well as in all kinds of grey-iron which contain earthy minerals.* Unless we have the exclusive use of a furnace, the di-

*These crystalline forms, so common in bombs, rarely occur in twenty-four pound howitzes, or in flasks. Out of thirty-eight ten inch and twelve inch shells, rejected for other reasons, which I have had broken, one third presented, in the fracture, crystallizations coloured yellow, crimson, &c. In six inch howitzes, we find rents produ-

mensions of the models, or globes, should be regulated according to the quality of the metal which in the particular foundry employed is best adapted for casting in sand, or for making most of the common cast iron utensils, and this is generally a mixed metal. The grey metal may also be used if it have the property of remaining liquid, which will be the case when the mixture of ore and fluxes is somewhat refractory; but if the grey metal should become thick and throw out a large quantity of graphite, it would give the projectile a very porous, wrinkled surface, covered with dross, and of an unseemly appearance. What we have said of the kind of metal best adapted for hollow projectiles, does not apply to that which should be used for making shot; white metal, or that which inclines to white, gives very ugly shot. The best is a slightly mixed metal, inclining rather to grey than to white, or else the clear grey metal, very liquid and having a pure slag. Such metal is easily obtained in furnaces fed with coke or charcoal. It is to be observed that the ore which furnishes brittle iron, whatever may be its colour, does not give as good shot as some of the ores from which medium, or tough iron is obtained; but the latter are generally of too much value for the manufacture in question. To obtain shot of an even surface, a certain quantity of the better quality should, however, always be added to the former kind.

We are at no loss to understand that white metal which, when poured into moulds, presents a very even surface, may furnish good shells, and at the same time be unfit for the fabrications of shot; because the latter must be rolled and hammered, and this metal is not adapted to either of those operations; the same may be said of almost all the ores of very brittle iron; they are not sufficiently ductile to take a smooth surface after having been hammered.

Grey metal which is a little thick, occasions, around the superior pole of the projectile, small cavities, very narrow and deep; especially if the metal has been reduced with coke of a bad quality, or from impure ores. In that case it contains a large quantity of silex, a part of which is separated from the metal by oxidation and cooling; if the ore is, besides, very fusible, the metal throws out graphite in cooling. This graphite and the silex thrown out are collected about the superior pole, where, mixed again with a certain quantity of metal, they form a soft spongy matter which gives a very bad appearance to the shot, and should cause its rejection—when metal

ced by the expulsion of the earthy minerals; but these substances are not entirely crystallized, because the metal of this projectile is thin and cools quickly. In the twenty-four pound howitzes these rents are for the same reason' very rarely found, and never in grenades. The pellicles which so often appear on the surface of projectiles, are produced only by the crystallization of the earthy minerals. These troublesome accidents may be prevented by keeping the metal for some minutes in the ladles; when poured into the moulds it then becomes well mixed, and the tendency of the foreign substances to separate from the mass is counteracted; as the metal cools more quickly this separation becomes less easy, and the flaws are neither so great nor so numerous. This precaution should not be neglected in the fabrication of projectiles; if the metal be used too hot, depressions and cavities occur in cooling. These depressions, which are found about the eye, on the interior surface of six inch and eight inch howitzes, and ten inch and twelve inch shells, are caused by rents which often extend from the centre of the thickness of the metal to its interior surface. In some foundries most of the rejections are caused by the faults we have just mentioned, and we cannot too strongly recommend to those charged with the manufacture of hollow projectiles to allow the grey metal, when very hot, to remain a short time in the ladles; especially metal obtained, as it generally is for this purpose, from impure ore.

entirely grey has been obtained by means of charcoal from refractory and rather pure ores, it becomes more liquid, throws out less graphite, and is more suitable for making shot of an even surface; but small cavities may still be seen at the superior pole.

Of casting hollow Projectiles.

The moulds for hollow projectiles are made of sand; clay was formerly used for the cores, but they are now also made of sand; at least it is to be hoped that this improvement will be generally adopted. Pit sand should be used for moulds; river sand has too little adhesiveness. It should be of a fine grain, and of such a consistence that it may stick together when pressed in the hands. If it contain too much earth it adheres to the casting, and gives it a rough surface: if too pure it has not sufficient consistence, and the moulds are easily broken and spoiled. The sand should however be as pure as it is possible to use it, in order that the surface of the casting may be more readily cleaned.

Sand which is too earthy may be easily corrected by the addition of dust from charcoal, coke or mineral coal, a very refractory substance which may be obtained perfectly fine, and which resists, in the strongest manner, the tendency to vitrification, and consequently to the adhesion of the sand to the metal. The dust of coke or of mineral coal is preferable to that of charcoal, and should *always* be used to give projectiles a fine surface. Calcination also furnishes the means of preventing the sand from adhering too strongly to the metal; and this method is naturally employed, by making use of the sand in which other castings have been made. It is necessary to mix it with fresh sand in order to give it greater consistence, and at the same time a certain proportion of the dust of coke or of pulverized coal is added.

Before using sand it is dried, then sifted, and properly worked and moistened: the quantity of water added should be the least possible to make it fit for use, because too much moisture may cause the casting to fail; there is however no danger to the workman in an excess of moisture, because the steam finding little resistance, passes easily through the sand without causing explosions, which often occur, in using clay moulds.

Of Sand for Cores.

Sand for cores should of course contain more clay than that used for moulds, in order that after having been dried the cores may be so hard as not to be easily injured, and that they may adhere properly to the spindles. If the sand contain too much clay the core would not dry thoroughly without long exposure to a very high temperature. This inconvenience may be remedied by the addition of pure sand, or of coke dust, and by drying a second time.

In general, the quality of the sand and the degree of heat to which the cores should be exposed are dependent on each other. It is easy to succeed by subjecting them a sufficient length of time to a high heat; but the results are more certain, the operation is quicker and less expensive, when the sand is of the proper quality, having sufficient consistence not to be easily separated, and at the same time not retaining water with so much force as to require exposure to a very high degree of heat. If sand of this quality is not to be found on the spot, it may be composed by mixing the different kinds, or even by adding clay, provided however that it does not contain too great a proportion of calcareous matter, the proportions of the mixture are

soon determined by trial. But it is especially important to regulate the operation of drying according to the quality of the material used; when the casting fails and the projectiles are full of flaws, it may always be attributed to the presence of moisture. Whatever be the quality of the sand, it is prepared as described under the preceding head; that which has been once used cannot be again employed without the addition of fresh sand.

Of Clay for Cores.

Although cores are now made of sand, we shall say a few words on the preparation of them from clay, and consequently on that of the clay itself: our remarks will apply also to the preparation of the nucleus of cores made of sand.

Argillaceous earth retains water with greater force, shrinks more in drying, and has a greater tendency to crack, in proportion, as it contains a greater quantity of alumina. The use of grey earths should be avoided, because they have not sufficient consistence; nearly all the earths which effervesce with acids are of this sort.

The clay is first dried, then pulverized, or rather beaten with a bat, to break the lumps, and sifted for the purpose of separating the pebbles, it is then moistened and well worked, adding at the same time about one third of horse dung. The viscous liquor contained in the dung prevents the clay from cracking, diminishes the shrinking, makes it less compact, less hard after drying, and easier to break when the shell is to be emptied. The clay used for the core of the *eye* should be passed through a silken sieve, and mixed with a smaller proportion of dung; the same may be said of that used for the last coats of cores made after the old method.

Of the models of Hollow Projectiles.

The globe, or model, is generally made of copper: it consists of two hemispheres joined by a tongue and groove, in such a manner that they touch each other only on the exterior circumference; the inner part should be bevelled at a large angle: this is an essential point, for by this form the seam of the projectile is made thinner than it would be if the two hemispheres touched each other on a larger surface. The metal should be from three to four lines* thick, so that it may not yield when the sand is rammed on it. The diameter of a model for any calibre is variable, on account of the different degrees of expansion and contraction of different kinds of cast iron: it always expands in passing from a fluid to a solid state, and afterwards contracts in cooling. This increase and diminution of volume varies not only in different foundries, but also in different kinds of metal obtained in the same furnace by working it differently.

In general the grey metal expands more in crystallizing, or contracts less in cooling, than the white metal; the former may give projectiles of too great dimensions, whilst those cast with white metal in the same moulds may be too small. The diameter of the model should therefore be regulated according to the quality of metal which, in the furnace employed, appears to be most fit for the object in view, and most frequently obtained. On the other hand

*The French measures are retained in this article without reduction to the corresponding dimensions in English measures, because the former bear nearly the same proportion to the latter that the corresponding calibres bear to each other in the French service and in ours; besides they are easily reduced if necessary, to English measures; a French foot being equal to 12.79 English inches, very nearly. TRANS.

it advantageous for the service that the diameters of the projectiles should agree as nearly as possible with those of the largest gauge used in the inspection; which diameters, for twelve inch mortars and twenty-four and sixteen pounder guns, differ eighteen points from the calibre of the bore, and for other pieces, one line. It is only by trial, making the globe at first too large, that we can obtain the proper diameter, which should be such that the greater number of projectiles shall not pass through the intermediate gauge. To obtain this result it often happens that, for large calibres, the diameter of the model should exceed, by several points, that of the large gauge.

The addition of the dust of coal, or coke, to the sand facilitates the cleaning of the projectile and makes the surface more even, consequently the diameter smaller, so that a greater number pass through the intermediate gauge, or even through the small one. If water be poured on the iron whilst hot, it contracts more. (*See casting and finishing Projectiles.*) Hence the necessity of being well acquainted with all the circumstances of the manufacture, when by the first trials, the dimension of the model is to be determined; if too small it cannot be corrected by a coating of tin, as has been sometimes attempted; it would be necessary to procure a new one, which occasions a considerable expense.

The model should be turned and finished in all its parts with the greatest precision. It was formerly the custom to flatten the models of all projectiles very much at the poles: it was thought that the metal contracted more in the horizontal than in the vertical direction. We have for a long time contended against this opinion. Experiments have proved to us that the alleged difference in the contraction of the metal does not exist. If projectiles, *of a medium weight*, moulded with spherical models, are sometimes elongated, it is to be attributed solely to the unskilfulness of the workmen, who have not sufficiently compressed the sand about the lower pole: it then happens, especially in the case of large projectiles, that the weight of the metal, causing the sand to yield, produces the elongation in question. When the workmen have the requisite degree of skill and intelligence, the models of all hollow projectiles, below the calibre of ten inches, should be perfectly spherical: by flattening them we obtain many flattened, and ill shaped, projectiles. If, on the contrary, the models are spherical, the workman soon learns to ram the sand properly, so that the number of elongated projectiles is very small, whilst nearly all the others are perfectly spherical. Workmen generally prefer flattened models, because they are more afraid of obtaining elongated projectiles which will be rejected, than of producing a quantity of others more or less badly made.

The models of ten inch and twelve inch shells may be flattened from four to six points, as the sand cannot always be rammed sufficiently to prevent it from yielding to the pressure of these heavy castings. This explanation of the cause of the elongation of projectiles overthrows an absurd opinion, which has generally prevailed; there are, however, other causes of elongation which will be explained under the head of moulding.

The upper hemisphere of the model is pierced with a round hole intended to receive an iron spindle; in twelve inch shells the hole is nine lines in diameter; the length of the spindle is seven inches, four lines: it consists of three parts; one part is cylindrical and cut with a screw thread; it serves to fix to the hemisphere of the model a sort of handle by means of which it is managed: the second part is a truncated cone, all the dimensions of which are perfectly similar to another conical part on the spindle of the core, and it serves to prepare for the latter a lodgment in the sand. The third part is

nearly cylindrical, having also a diameter equal to that of the spindle of the core. In speaking of the flasks, we shall return to this subject. The upper hemisphere of the model of shells is pierced besides with two rectangular holes for the ears. Their position and form have undergone several variations; the following is the usual manner of tracing them. On a diameter perpendicular to the axis passing through the eye, lay off on each side three inches three lines, draw perpendiculars at these points, and with the radius of the twelve inch shell increased by that of the hole in the ear, cut the two perpendiculars at points which determine the centres of the holes: all shells being similar figures, the centres of the holes will be always found on the same radii. The diameters of these holes are laid down at four lines six points, for the twelve inch shell; three lines nine points, for the ten inch, and three lines three points for the eight inch. In practise it is necessary to make them a little larger, to afford the requisite play to the rings. It is essential that the mortices for the ears should be large enough to admit of their remaining in the sand, with the rings, after the hemisphere has been removed. Each ear is divided into two parts, which are generally joined by a tenon, so that they may be easily withdrawn in succession, without displacing the ring.

The ears placed as we have said, on a great circle, ought to fit accurately on the sphere, and form with it a continuous surface. The rings which are semi-elliptical, should be made with great precision, and finished with the file, so that the brazing, which is on the straight part, may not be visible. They are made of iron wire about two-fifths of an inch thick: it is necessary that they should play freely in the ears, and should fall down entirely on the surface of the shell. The diameter of the hole which they make should therefore be greater than their own: this is effected by enveloping them with a coat of clay, which should be quite round and well dried. When the shell is cast, this clay being removed, the ring has the requisite play.

The lower hemisphere of the model is also pierced with a hole which receives a piece called the *false spindle;* its dimensions are arbitrary; it is pierced at the inner end, with a mortice which receives a key. The other end is also pierced with a square hole in which is introduced a bar of iron or small ruler. The object of this spindle is to prevent the model from being detached from the mould when the flask containing it is raised; for this purpose a bit of wood is slipped under the rule; this acting like a wedge against the edge of the flask raises the rule and consequently presses the mould against the sand.

Of the Spindle of the Core, and of the Pattern.

The spindle of the core is divided into two parts by a swell several lines in height, in the form of a truncated cone, the base of which nearest to the core, has a diameter only three or four points less than the greatest diameter of the eye. The diameter of the other base is a little smaller than the first, in order that the spindle of the model, which should be perfectly similar to that of the core, may be withdrawn from the sand without causing any derangement of the mould. The dimensions of the part of the spindle opposite to the core are determined by the height of the flask, as we shall see further on. The part which supports the core, added to that which forms the eye of the projectile is equal in length to the distance from the upper circumference of the eye to the bottom of the shell, less a small quantity, and varying with the calibre: it is not important whether it be a little longer or a little shorter; the only essential point is that the swell and the part of the

spindle opposite to the core, should be perfectly equal to their corresponding parts in the spindle of the model, and that the length of the swell be strictly determined according to the dimensions of the flask. We shall return to this subject.

The spindle may be either solid or hollow. Solid spindles having one or two deep grooves extending through their whole length, are also pierced, at the part which supports the core, with two rectangular holes in which pieces of slate are placed, to support the clay. In these grooves are placed straws to facilitate the disengaging of the gases. Hollow spindles intended principally for cores of sand, are pierced with five or six holes two lines in diameter. I think the latter kind preferable; they are besides easier to make, lighter, and less apt to spring than the solid spindles; they are made of sheet iron fifteen or twenty points thick, cut into pieces of proper size and rolled hot on a mandril. It is not necessary that the edges should be brazed together; it is sufficient that they join. The swell of the spindle is made by a ferrule which is brazed on. It is essential that the ferrule and all that part of the spindle which is to be similar to the spindle of the model, should be turned to the exact dimensions required. Both kinds of spindles should be flattened at the end opposite to the core, in order that it may enter into a crank; in that part there is also a hole to receive a key, when the core is placed in the mould. The other end should have a small conical indentation to receive the point of the screw which serves to fix the spindle in the lathe.

The dimensions of the core are determined by means of wooden patterns, of which there should be three, because the core is not finished at one operation. The radius of the first pattern differs ten lines, of the second four lines, from that of the core when finished; the third should give an exact section of the core, including that of the eye. The pattern is very easily drawn, for all its dimensions are given by those of the shell. A similar profile, made of iron, a gauge, and calibres for the eye, serve to verify the dimensions of the core. Before entering into the details of moulding, we shall describe the flask.

Of the Flasks.

The flasks are boxes of wood, or of cast iron, without bottoms, divided into two unequal parts, each of which contains the mould of a hemisphere, and which are joined together by dowel pins, wedges, hooks, or small bolts and keys: the connexion by means of screws seems to me very defective.

The thickness of the boards of which wooden flasks are made should be from fifteen to eighteen lines for ten and twelve inch shells, and from ten to twelve lines for other projectiles. Wooden flasks are generally square; three of the angles are partly filled by triangular prisms of wood, to increase their solidity and diminish their capacity. The size of the flasks should be such as to leave a space of about an inch, or an inch and a half, around the model: if this space were greater, the preparation of the mould would require too much time; it would increase the expense, and at the same time impair the result of the operation, because the sand always yields more or less to the expansion of the metal, which is greatest at the points of least resistance, and this effect will be greater where the sand is thicker, the difficulty of ramming it firmly, being then increased. The part of a flask which contains the mould of the hemisphere in which the eye of a shell is placed, we shall call the *drag*; the other part the *cope*. The former which is ten inches eight lines deep for twelve inch shells, and to which the slides that receive

the wedges are adapted, contains a cast iron traverse, reinforced in the middle of its length, and pierced with a hole. The depth of this hole, or the thickness of the bar, or traverse, is four inches; its width is arbitrary. The hole, which is nine lines in diameter, receives the spindle of the model, the swell of which should rest exactly against this bar, as should also the swell of the spindle of the core. Accuracy in the position, and consequently in the thickness, of the sides of the projectile, depends therefore on the precision with which the bar is made and fixed in its place, as well as on accuracy and perfect identity in the form of the spindles.

This bar, or traverse, is therefore the most important part of the flask. If it were bent up or down the thickness of metal at the eye would be too great or two small: if its position were deranged laterally, the position and direction of the eye would vary accordingly. In verifying the flasks therefore the principal attention should be directed to the position, dimensions, and solidity of the traverses. They are let in their whole thickness into the sides of the flask, and kept in their places by screws, straps and keys. The depth of the drag is generally determined by the semi-diameter of the model added to the height of the swell of the spindle, and the thickness of the traverse. The sum of these three dimensions is ten inches eight lines for a twelve inch shell. The depth of the cope is equal to the semi-diameter of the model increased by two or three inches allowed for the thickness of the coat of sand: that depth is consequently from eight inches to nine inches in the example we have chosen. It may without inconvenience, be greater; but no variation can be allowed in the depth of the drag, unless corresponding variations are made in the spindles or in the thickness of the traverse.

When the flask is so arranged that the shell is cast with the eye downward, it is necessary to give the cope a greater depth than it would require if the shell were cast with the eye uppermost; because in the former case the sand in the cope is supported by the board on which the flask rests, but not in the latter.

Cast iron flasks have a round form with a swell or projection at the part where the gate is placed. The sides may be vertical, or may consist of two truncated cones placed base to base, giving a swell in the middle of the height. The two parts are connected together by dowels and ears through which key bolts pass. The traverses should be cast separately, and the holes drilled cold, to secure greater accuracy. In casting them at the same time with the flasks it would be impossible to avoid slight variations in all their dimensions; cast iron flasks are far preferable to wooden ones, because they can be better joined, and are much less subject to derangement, and the traverses can be adjusted in them with greater precision and solidity. We have already said that there is an advantage in having the coat of sand thin; but in that case the wood, affected by the heat and steam, becomes warped, which always causes errors in the dimensions of the projectile: hence another reason in favor of cast iron flasks.

The *gate* or channel by which the metal is conducted into the moulds is curved and terminates at the extremity of a horizontal diameter of the mould. It is called a *heel gate*, and it is formed in the sand by two pieces of wood, one of which, placed vertically, has a conical form: the diameter of its greater base is two and a half inches, that of the lower base is nine lines for twelve inch shells, and its height is necessarily equal to that of the upper portion of the flask: the other piece of wood which forms the heel, is

placed horizontally, meeting the model on one side and the vertical piece on the other; its ends are therefore cut to correspond respectively with the surface of the vertical piece and with that of the model; its form is flattened. The first of these pieces of wood is called simply the *gate*, the other the *heel*. In describing the process of casting we shall mention the several instruments made use of; but we must first say a few words on the subject of the lathe used for forming the cores made of clay, and the nucleus of those made of sand.

(TO BE CONTINUED IN OUR NEXT.)

On Calcareous Cements. By JAMES FROST, Civil Engineer.

No. IV.*

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Having seen the intense affinity between lime and water, we will now endeavour to examine the superior affinity between lime and carbonic acid; with which lime is always found naturally and definitely combined in the proportion of twenty-eight lime and twenty-two carbonic acid. It is also, generally or always found mixed, and seemingly in combination with other substances; for, in the purest white Italian marble I have always found some minute silicious particles. Yet, carbonate of lime we shall hereafter find is never chemically combined with those other substances—whatever may be the hardness or specific gravity of the mass;—and as this is seemingly a position of some importance in geological investigations, it will be hereafter adverted to in connection with another part of equal importance, when we have had the advantage of considering some other combinations of lime.

In England, lime is generally procured by calcining the carbonates in two different modes. The one and most frequent, is the cheapest and easiest in practice, but the lime obtained in this way is generally found inferior in quality to that obtained by the more troublesome and expensive process.

As lime of as good quality may be obtained by the easier process, we will endeavor to describe the necessary conditions. In the first mode, the carbonate is interstratified with the smallest and cheapest coal, in inverted lime kilns, and the fuel being in actual contact, acts with the greatest effect. The kilns are of the cheapest construction and maintenance, and being daily emptied of a portion of calcined lime, and daily charged with an equal proportion of fresh materials, the business is regularly conducted in the easiest manner—but the lime thus obtained is of a variable quality from some causes which must be explained in order to be avoided.

In the second mode the carbonates are piled in kilns so constructed that the fuel is burned in furnaces, and only the flame thereof admitted into the kilns to calcine the lime. In this mode, the coals used are large and of the dearest kind; more of them are required, as they do not act with so much effect; constant attendance is required night and day during the calcination; the kilns are more costly in construction and maintenance, and much expensive iron work is required.

If we calcine some limestone in an iron tube, or retort, set in a brick furnace, and then allow the retort to cool very slowly, while another portion of limestone is being calcined in a similar retort which is connected by an iron tube with the first so that the carbonic acid gas may be conducted

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into the first retort, it will be there absorbed by the hot lime, which thus becomes uncalcined as it were, and is recarbonated more or less according to the care taken in conducting the experiment.

If we now enquire why the first mode is so uncertain, we shall find that the kilns are commonly constructed about equal in diameter and depth, and that the most careful workmen find it difficult, or impracticable, to draw the calcined lime, so that portions of it do not intermix with portions of the uncalcined and of the fuel. In which case, a portion of uncalcined lime escapes calcination, and a portion of that which is calcined becomes more or less uncalcined, and a very irregular article is thus produced.

If lime kilns were always constructed of two or three diameters in depth, careful workmen might always draw without intermixing the calcined and uncalcined strata in the kilns, and a good article would always be produced at the least expense of time and trouble, and that this mode will succeed in practice with any description of limestone, will be apparent, when we state that the most difficult carbonates to calcine, are those employed in the production of cements, which must be sufficiently calcined to become tender for grinding, while from their chemical qualities they are easily fusible with a small excess of fuel; now as these carbonates are well calcined in such kilns, it must be evident that all may be so, as no others can, from their nature, be so difficult to manage.

In either of the two modes of calcination the lime is allowed to cool in contact with atmospheric air, and this we have already seen is essential to the production of lime. For, if having calcined lime in a reverberatory furnace, wherein coke has been used for fuel, and if then a fresh supply of fuel be added, and the supply of fresh air prevented to the furnace and to the chimney, by closing the apertures thereto, and the lime be thus allowed to cool, it will absorb and condense much sulphuretted hydrogen as well as carbonic acid gas, and when cool, will be incapable of slacking with water, and if pulverised and tempered with water, it will set as cement, for a long time thereafter, exhaling the peculiar odour of sulphuretted hydrogen.

If, when the lime is about to be thus cooled in a reverberatory furnace, a portion of pine wood is added to the other fuel, the lime when cool, will be found nearly black throughout its whole substance by the vapour of carbon which has penetrated and been condensed therein; a black cement has been thus obtained, coloured probably, as some black marbles are found by analysis to be; the Kilkenny or black Irish marble, owing its color to its containing two per cent more carbon than white marble, which always holds twelve per cent combined with oxygen in its carbonic acid, and Kilkenny marble holds only two per cent more, but being uncombined, it acts as colouring matter, showing what a great difference in sensible qualities is made by a small difference in the quantities and chemical arrangement of the elements of solid bodies.

Every different species of carbonate requires a different quantity of fuel for its due calcination, the argillaceous varieties requiring a quantity very nearly proportioned to the carbonic acid in them; hence, the inference is, that the heat evolved is essentially employed in converting the acid into permanent gas. Thus, two measures of small Newcastle coals, are required for the calcination of ten measures of Thames chalk, and is sufficient for fifteen measures of Roman cement stone; but as this latter substance is about one third ferruginous and argillaceous matter, it would seem to require the expenditure of little fuel for that portion. As a measure of chalk is about

twice as heavy as a measure of coals, it follows that, ten pounds of coals are required to calcine 100 of carbonate, or one pound coals to 4.4 pounds carbonic acid; but as eighty-four pounds of the live coals would heat and evaporate twelve cubic feet of water, one pound of coals would heat and evaporate nine pounds of water. We thus find by rather a rough process, but from facts correct enough for general reasoning, because derived from operations conducted on the large scale, that the latent heat in carbonic acid gas, is about double the latent heat of steam.

If 37 parts hydrate of lime is placed in contact with 22 carbonic acid, the nine parts of water in the hydrate will be all expelled, and the carbonic gas combining in a solid form with the lime gives out its latent heat, which being taken up by the water, it escapes in the form of vapour, or steam of superior elasticity to the atmospheric pressure, although its temperature is insensible, this very curious or rather wonderful fact, and others, hitherto, I believe, wholly unnoticed, we shall see amply verified when we examine the properties of cements.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Production and Manufacture of Salad or Table Oil in the United States.

The following remarks are intended to apply to that strip of the United States, which is comprehended between the latitudes of Cape Hatteras and Boston bay, extending westward.

Although there is no part of this extensive region in which the olive tree could be cultivated, except when protected by the green house, and therefore, the inhabitants are denied the advantages of this useful tree, it does not follow, that nature has denied them the means of procuring an excellent and pleasant substitute for olive oil, and one that could be brought into market at a moderate cost. Between them and this enjoyment, ignorance is at present a barrier, and in this case, as in many others, this is strengthened in its result, by prejudice.

In French Flanders, the farmers cultivate in large fields, and to a great extent the *White Poppy*. The seeds of this plant are collected and bruised in some way, and an oil expressed from them, which in all respects resembles olive oil, and is the source from whence is derived a large proportion of what is consumed in Paris. The poppy oil so much resembles olive oil, that strangers who visit Paris take it for that oil. These are facts as regards the consumption.

Of the state of this important branch of husbandry and manufacture, we the people of the United States know nothing. How is it cultivated, the seed collected, the oil preserved? Does the land require to be sown every year, or does it seed itself? What sort of a mill does it require? What is the product in oil, or in profit? In short, we have every thing to learn, except that, incidentally we have heard that fifty pounds of beet cake, after the sugar maker has got what he wants out of it, and ten pounds of poppy seed after the oil maker has done with it, will keep ten sheep a day and fatten them.

We know that since the article on beet sugar appeared in the Journal of the Franklin Institute, requesting those who knew any thing of the subject to favour the editor of the Journal or the public with information, a well

qualified agent has been sent to Europe to acquaint himself with the whole agricultural and manufacturing business that produces sugar.

On the present occasion, we invite the patrons of our country's industry and resources, to communicate for publication, what they know on the above interesting branch of French husbandry, &c. And we therefore request the wealthy and patriotic, to consider whether the case of oil does not resemble that of the sugar from the beet, and whether the best course would not be to adopt a plan similar to that which the friends of beet sugar have chosen.

The time will come when American parents will send their sons to Europe and to other foreign places, to learn the manufacture of beet sugar, of oil, and such other branches of the arts not possessed by us, in the same manner and with better reason that they now do to have them learn medicine and surgery.

June 4, 1836. J. R.

Civil Engineering.

Some suggestions on the Location and Grading of Rail Roads.
By Thomas Earle.

In the location and grading of rail roads, it is usual to reduce the road in all parts, as near to a level as possible, and in effecting this object, to make many curvatures, some of them of small radius. Thus, a very considerable increase of expenditure and of distance is occasioned, which appears to me inexpedient.

It is true, that if a rail road could be made perfectly level, or very nearly so, without being unreasonably curved, such a road would be better than an undulating one: because the locomotive engines would require to be transported less frequently over the ground, to convey a certain quantity of goods on such a road, although the expenditure of steam for conveying the train, independent of the locomotive, would be as great on the level road as on the undulating one. A perfectly level road, however, is impracticable in most parts of the country, except at an expense far exceeding the value of the benefit gained. Hence, it is probable that few roads will hereafter be made, without ascents and descents, in some parts, at the rate of forty to fifty feet per mile.

Such ascents being admitted in some parts of the road, the locomotives will take no greater trains than they can draw up those ascents. Hence, it will be useless to make excavations, embankments, and curvatures, to avoid other ascents of the same grade.

A locomotive will take a train up an ascent of twenty-one feet to the mile, and down a descent of the same length and grade, with precisely the same expenditure of steam, if it be constantly used, as would be required to take the same train over the same distance, on a perfect level. If the train were such as to require for drawing it on a level, a pressure of steam on the piston of thirty-six pounds to the inch, above the atmosphere, then on the ascent of twenty-one feet per mile, it would require sixty-three pounds per inch, and on the descent of the same grade, nine pounds per inch, making the average thirty-six pounds or the same as on the level.—Thus, $63+7=72\div2=36$ pounds.

If, however, the road were composed of alternate ascents and descents, at the rate of from thirty to forty feet per mile, with but short levels between them, the engine would transport such train as it could draw on the road,

with a *less* expenditure of steam than it would require to transport the same train on a level. This might be effected by shutting off the steam from the piston on descents, and suffering the train to progress by its own gravity. The saving in this case, compared with the other, would arise from dispensing, on half the distance, with the amount of steam, viz: about fifteen pounds to the inch, which is required to overcome the external resistance of the atmosphere. There would also be a further saving from the constant use of high steam, if the supposed fact be correct, that a certain volume of steam under a pressure of one hundred pounds to the inch, can be produced with less than double the fuel which is required to produce the same volume of steam under a pressure of fifty pounds to the inch.

And the result, as to the expenditure of steam, will be equally favourable on ascents and descents, as great as fifty feet to the mile, (excepting the before-mentioned inconvenience of transporting the engine a greater number of times over the ground) as with ascents and descents of a less grade, provided the inclined planes be not so long as to require the checking of the velocity of the train, by artificial means in descending: for the momentum acquired in the descent, will continue the motion on the succeeding level or ascent, until the power expended in overcoming gravity in ascending, is reimbursed.

It is further to be observed, that if there be admitted on a road, inclined planes of several miles in length, and of a certain grade, *shorter* planes of a higher grade may be admitted on the same road, without inconvenience, because the momentum acquired by the velocity of the train, before commencing an ascent, will give considerable assistance in overcoming it. A velocity of twenty miles per hour would give a momentum, if I have estimated it rightly, sufficient to raise the train about twelve feet in perpenticular height. Thus a road having long inclined planes, graded at forty feet per mile, will admit those not exceeding two thirds of a mile in length graded at fifty feet, or not exceeding one third of a mile in length, at sixty feet.

Hence, it is unnecessary, on long inclined planes intended for locomotives, to make them of uniform ascent, as the momentum gained where the ascent is below the average, will assist in overcoming the resistance where it is above.

The making of curves in rail roads, to avoid slight ascents and descents, is productive of several inconveniencies.

1. It increases the cost of the road, by its greater length, and proportionably greater expenditure for land, foundation and rails.

2. By the increase of length, the time of travel and the expenditure of steam, is increased in nearly the same proportion.

3. The expenditure of steam is further increased, in overcoming the strain and friction occasioned by the operation of the wheels on the curves, the power expended not being re-imbursed, like that expended in overcoming ascents. The resistance on short curves upon a level is found to be greater than on a straight ascent of thirty feet per mile.

4. The wear of carriages and locomotives, and their liability to break or become disordered, is increased by the greater distance, and by the strain on the curves, which racks every part of the machinery to a degree much complained of by practical engineers.

5. The wear of the rails, and their liability to disorder is increased.

6. The danger of running off the road is increased.

Hence, a road should be made as straight as possible, without a great increase of expense, and without encountering ascents unreasonably great.

I will add a suggestion in relation to cars for burthen. The greater the load carried by each car, the less will be the weight and cost of cars, compared with the goods transported. Materials increase in strength in proportion to the cube of the diameter, while the weight and volume increase in proportion to the square. Hence, the cost of materials, workmanship, and transportation of cars, will all be reduced, by using as strong cars with as great loads as the road will permit. A further advantage in strong cars and heavy loads to each, will be found in shortening the train, and thus decreasing the strain in turning curves. As locomotive engines with six wheels are used, weighing with their water and fuel, eighteen or twenty thousand pounds, I can see no serious objection to the use of burthen cars of four wheels, weighing with their load, five and a half or six tons, with a proportionate increase of weight when six or eight wheels are used.

Objections have been made to the matter contained in the forepart of this essay: 1. That on an undulating road, the steam must be blown off and wasted on descents, owing to its superabundant quantity: 2. That although none were used on descents, the pressure of steam could not be kept up sufficiently, because none would pass through the flue to aid the draught. The two objections are contradictory of each other. They can both be obviated by proper power in the boiler, with an adequate steam chamber, and by proper attention to the supplies of fire and water. They are not felt as serious inconveniencies with the best engines on the Columbia Rail Road. There is one plane on that road of upwards of ten miles, and another of seven miles, where the cars will descend by their gravity. The engineers cause a fresh supply of water to be put in the boiler at the head of the plane, and no fuel till near the foot of it, and thus they avoid the necessity of blowing off steam. If they were to add fuel, they would have to discharge steam, which shows that both objections are of little importance, in comparison with the advantages of a straight road at a diminished expense.

If it should be found that without particular attention to the addition of water and fuel on descents of moderate length, where the train progresses by gravity, there will be an inconvenient surplus of steam, the difficulty can be obviated by the use of a damper to check the draught.

Physical Science.

Proposed forms of diagrams for exhibiting to the eye the results of a register of the direction of the wind. By A. D. Bache, Prof. Nat. Philos. and Chem., Univ. Penn.

My attention has been recently recalled to the subject of diagrams for showing the results of a register of the direction of the wind, by the first number of a meteorological publication,* received through the politeness of its author, W. R. Birt, Esq. of London. At one of the early meetings of the joint committee of the American Philosophical Society and Franklin Institute, appointed in 1834, I laid before the members several plans for the purpose above referred to. These, I propose now to make public in the

* Tabulæ Anemologicæ, or tables of the wind; exhibiting a new method of registering the direction of the wind, &c. &c. By W. R. Birt.

hope that one or other of them may prove acceptable to meteorologists. They exhibit to the eye the results of observations at the same or different places, thus facilitating the study of their connexion. One of the plans was considered preferable to the others by my colleagues of the committee, but as it may not be the most convenient under all circumstances, I have presented the varieties of the register as laid before the Committee. The scheme shown in fig. 4, plate 1, will be found to resemble in appearance that proposed by Mr. Birt; but the principle will be seen on examination to be entirely different from the one adopted by him.

The figures are placed in the order in which the methods suggested themselves. The first is probably the most natural form of diagram, and was the first which occurred to me, while the others are successive modifications growing out of difficulties, or objections, which appeared in studying the subject. The first was preferred by my colleagues of the committee as best accomplishing the object, while the last is adapted to the ordinary form of diagram used to represent the variations of the thermometer, barometer, &c.

A register of the wind should not only show its direction at the time of observation, but the direction through which it may have passed when changing from one point of the compass to another. A diagram illustrating such a register must admit of an easy mode of expressing the results, and the less artificial this method the better will it answer the purpose of addressing the eye. In his valuable meteorological essays Professor Daniell has adopted a method of representation first used, I believe by Mr. Howard. A horizontal line is drawn and points assumed upon it at convenient, equal distances, to represent the times of observation. Above this line points are assumed at regular intervals, to denote the points of the horizon between west and east, by the north. Supposing the cardinal and ordinal points only to be marked; the north west point will be on the left hand, and the east on the extreme right. The positions assumed for the points of the horizon will of course depend upon the degree of nicety to which it is intended to note the direction of the wind. From any one of these points to one of those in the horizontal line first assumed, representing the times of observation, a line being drawn represents the direction of the wind. A similar arrangement is made below the first horizontal line or at the foot of the diagram, if it is also to exhibit the state of the barometer, thermometer, &c., for the points from west to east, passing through the south. This method does not admit easily of expressing the direction through which a wind has changed, and the lines of direction of the wind, sometimes cross each other at such acute angles as to render it difficult to trace them. For example, when at the close of a month the wind is north westerly for several successive days, the lines expressing this fact cross the whole figure. They meet other lines sometimes quite obliquely, and being but slightly inclined to each other, the eye does not readily follow them. These remarks are not offered in the spirit of criticism, but merely to point out why I thought it advisable to obtain a different scheme of registry.

The ordinary method of representing the rise and fall of the thermometer or barometer, is a natural one; equidistant points on a horizontal line being taken to represent the times of observation and the perpendicular lines drawn through these points, or corresponding ordinates, being made proportional to the height of the column of mercury. In like manner the wind being registered with reference to the points of the horizon, the natural system of representing it is to assume a system of concentric circles the in-

tervals between which shall correspond to equal intervals between the times of observation, and the angular divisions upon which shall correspond to the rhumbs. Such a scheme is represented in figure 1, plate 1. In order to bring the figure within the compass of the page, it has been necessary to make it so small that it does not fully show the advantages of the plan. A diagram in which the outer circle is seven or eight inches in diameter admits of entire distinctness, when observations are not more frequent than four times during twenty-four hours, even at the season when the wind is most variable. Where observations are frequent, the interval between the concentric circles may conveniently represent a day, the first circle corresponding to twelve o'clock at night, on the last day of the preceding month, and the second to midnight of the first of the month, and so on. The observations at intermediate hours will be placed in their appropriate positions between the two circles just referred to, and the registry will be carried on in a similar manner throughout the month. In the case actually represented, fig. 1, plate 1, the regular observations were at 3 P. M. of each day, and I have drawn the concentric circles, represented by the finer lines, to correspond to this time. The intermediate observations when a change of wind required their use, have been placed within or without the several circles, according as they were made before or after 3 o'clock of the particular day to which the circle corresponds. The variable month of April has been selected for representation, as putting the diagram to a severe test. The circle having been divided as shown in the figure, so as to point out the cardinal or ordinal points, a dot is placed on that radius corresponding to the point from which the wind blows. Thus, on the 1st of April, 1836, at 3 P. M. the wind at Philadelphia was S. S. W. the dot numbered 1, is on the first circle recking from the centre, at the intersection of a radius, which would bisect the angle S-W. *c.* S. On the 2d at 3 P. M. the wind was N. W. a dot is therefore placed to denote this on the second circle, at the intersection of the radius N-W, *c.* The table from whence the direction of the wind was taken* shows that the wind passed from the S. W. to the N. W. through the west as is expressed by the curve 1, 2, passing through the west point. On the 3d the wind was S. W. as denoted by the dot at 3, having passed back by the west, which direction therefore the curve 2, 3, is made to intersect. The wind passed the S. W. to S. S. W. between the 3d and 4th, as is shown by the curve 3, 4. It remained at this point until the morning of the 5th, as indicated by the straight line from 4, when it changed by the west to N. N. W. Passing this point to the north in the evening of the 5th, it returned to the N. W. on the 6th. It is hardly necessary to trace the courses further to show how the diagram represents the results of the table, but it is probably worth while to refer to one of the cases, when the change of the direction of the wind is not through the smaller angle between its two directions. On the 10th of April the wind was N. E. as indicated by the dot 10; on the 11th, it was N. W. having changed round by the South as fully represented in the curve 10, 11, which sweeps through the angle of 270°.

One objection occurs to the curves between the times of observation, namely, that they represent the wind as gradually changing, whereas, in fact it frequently ceases, an entire calm preceding the wind from the new direction. This false impression is entirely avoided in such a case, by a system of numbers, or symbols, representing the force of the wind. These

* Kindly loaned to me for this purpose, by James P. Espy, Esq.

being placed in brackets, can not be mistaken for the numbers representing the days of the month, which it may generally be found convenient to place upon the points corresponding to the principal observation of the day. A curve being traced to a certain point, and found to terminate there a zero in brackets (0) will show a calm, and avoid this being taken for another case, which might occur in a defective register, namely, that in which the direction of the change was not noted. If the observations are frequent the curves will be traced entirely from them and will be of course, therefore, the more accurate, as the observations are more numerous. If there should be but one regular observation during the twenty-four hours, the direction in which changes take place being, however, noted, the dot will serve to point it out, and it will be easily understood that the curves merely show the angle of direction through which the change took place. The character of the weather may readily be entered on the diagram, which to accommodate such remarks should have its first circle farther from the centre *c*, than in the figure, the object of contracting which has been already stated.

Before I became familiar with the use of the first diagram, the considerable extent of the outer circles seemed to me quite objectionable and I therefore separated the monthly register into three parts as shown in figure 2. The left hand figure contains the observations of the first ten days, the middle figure of the next ten, and the right hand figure, of the last eleven days of the same month, which is registered in figure 1: The diagrams are strictly comparable as exhibiting the same results. The middle set of concentric circles is connected with the first by a dotted circle within that denoting the eleventh day of the month. On this circle, which corresponds with the tenth of the left hand figure, the observation marked on this latter is placed. Thus on the 10th the wind was N. E. as shown by the dot at the intersection of the radius N-E. *c*, on the outer circle of the left hand set. This mark is transferred to the dotted circle of the middle set and the curve traced between the dot and that, for the direction of the wind on the 11th, shows the angle through which the change from N. E. to N. W. took place. The concentric circles should commence with an inner one of more considerable diameter compared with the outer, than those on the plate, in order that the weather, clouds, &c. may be registered. The advantage of this mode of registry, or of illustrating a register in the easy comparison of results is in part lost by thus dividing the figures, an objection which led me to the scheme shown in figure 3.

A sector of a circle is taken, and similar arcs numbered I, II, III, &c. traced to denote the periods of observation. The central radius being assumed to indicate the north direction, the two extreme ones correspond to south. Proportional divisions of the angle between the lines S *S'*, S *S'*, give the other points of the horizon. In the figure a sector of 90° is taken, instead of the whole circle or 360°. This diagram represents the results of the same table which is illustrated by the other figures. Since there are two lines corresponding to a south direction, there are two corresponding points to be marked when the wind is south, or when it changes round by the south. Thus, on the 10th, at 3 P. M. the wind was N. E. as shown by the dot at 10 on the arc X, at the intersection of the radius N-E. *c*. On the 11th it was N. W. changing by the south through the E. &c. The curve passes across the E. and S. E. directions to the S, then from the corresponding point on the left hand line, S. *S'*, across the S. W. and W. directions to

the N. W. This want of continuity is the only material difficulty in the use of the diagram. The system, however, is quite artificial.

By an easy transition the plan shown in figure 4, is derived from that just described. If an artificial system is to be resorted to, the convenience of using common ruled sheets employed for meteorological registers, would give it the preference.

Before describing this diagram, I propose briefly to state the means of representation adopted by Mr. Birt. This is done to show that the method now presented really differs from the one proposed by that gentleman, though in appearance resembling it. I assume, as a matter of course, that before deciding which of the two schemes would be preferable, the diagrams of Mr. Birt, to which I have before referred, and his own description, would be consulted.

A particular direction is assumed as that in which the greater number of winds at a certain place are found to blow, this, for London, is stated by Mr. Birt to be N. E. and S. W. This is called the anemonal direction, and a circle representing the horizon being divided by a diameter indicating this direction, the other rhumbs are denoted by their distances from this line. To construct a diagram for registry upon this principle, a line is drawn, representing the anemonal line, on which equal distances are laid off to correspond to equal intervals between the times of observation. Lines perpendicular to the anemonal direction are then drawn, on which to set off the ordinates representing the directions of the wind, according to the principle above stated. This amounts, in any case, to setting off a distance proportional to the sine of the angle which the direction of the particular wind makes with the anemonal direction. The assumed anemonal direction being N. W and S. E. all winds from N. W. round by S. W. to S. E. are set off below the line of anemonal direction and all from N. W. round by N. E. to S. E. above the same line. But there are still two equal sines belonging to the opposite quadrants of each of these semi-circles, so that the same ordinate would represent a N. and an E. wind, or a W. and a S. one. To distinguish between these, the changes of wind from N. E. to S. W. by the N.W.are recorded by a single line, and those between the same points round by the S. E. by a double one. In practice, the ordinates are not laid off in the strict proportion of the sines, but after the points at 45° and at 90° from the anemonal direction have been thus fixed, the distances are divided into a convenient number of equal parts.

The table of Mr. Birt includes not only the register to which I have just alluded, but one of the upper current of air, as denoted by the motion of the clouds. A register of the clouds by a peculiar nomenclature devised by him, and a register of the weather by significant letters according to a system of Lieut. Becher. Although not relevant to the comparison in hand, I mention these points that there may be additional motives to consult the interesting document to which I refer.

According to my scheme in fig. 4, plate 1, the equal distances 1, 2; 2, 3; &c. correspond to equal intervals in the times of observation. The line N. N. represents the north direction, the lines S. S. and S. S. the south. The intermediate lines, at equal intervals, give the N. E., E. &c. and the N. W., W., &c. points. The observations being shown by dots, the lines joining these latter will denote the direction of changes. A south wind is recorded in the upper and lower lines S. S. as in the case of the 13th of April, shown on the diagram. A change of direction by the south

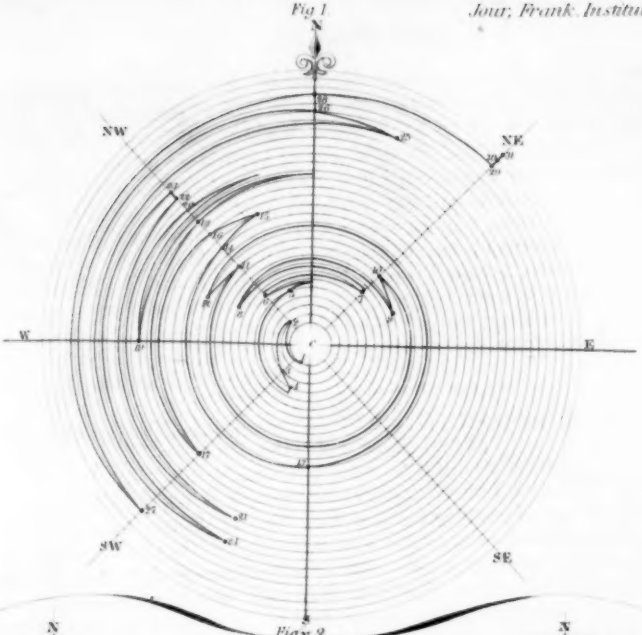


Fig 2

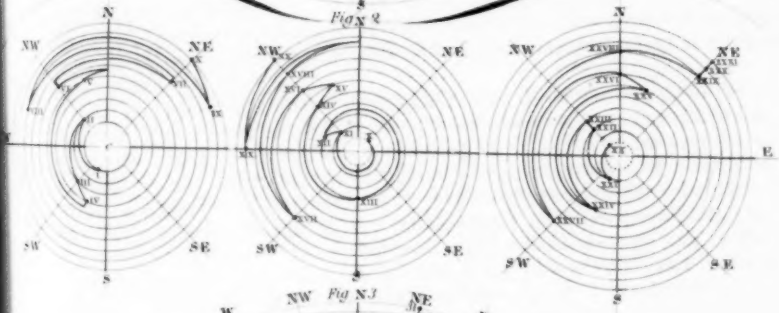


Fig N.3

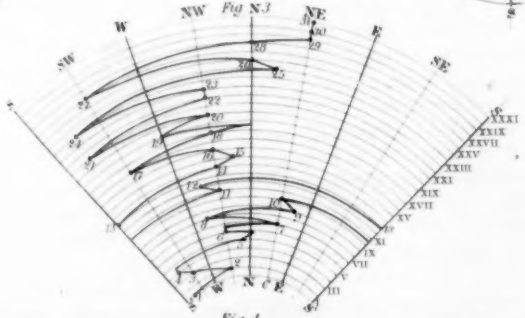
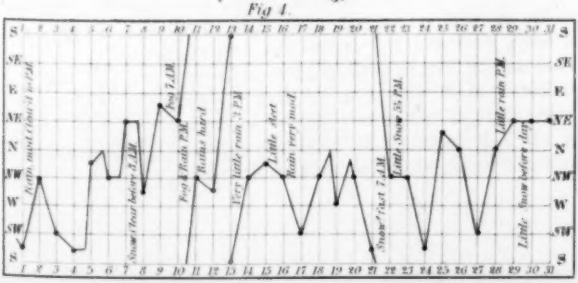


Fig 4.



Engraved by J Yeager

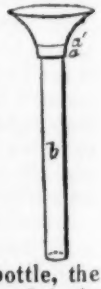
is similarly recorded, and renders the broken line joining the points registered, discontinuous. This case is shown between the 10th and 11th of the month, when the wind changed from N. E. to N. W. by the south. The eye soon becomes habituated to this form of diagram, artificial as it is, and can follow the directions of the wind in its changes, with considerable facility. The diagram, however, requires habit to render it acceptable, and I am not sure that the connexions are ever as well seized as by the first plan submitted. The extent of the diagram, to ensure distinctness, is quite inconsiderable, which is a recommendation. The record of the weather may be very conveniently made upon it, and as has been before remarked it may be formed on a sheet intended to trace the fluctuations of the heat, pressure, or moisture of the air, without any material change in the kind of diagram adapted to their registry.

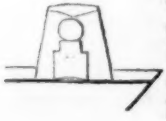
Experiments on Endosmosis. By JOHN W. DRAPER, M. D., Christiansville, Mecklenburg, Va

(CONTINUED FROM p. 182, Vol. XVII.)

17. The doctrine laid down in sections 13 and 14, of the condition of equilibrium of gases, on each side of a membrane, being the foundation of an explanation of all the phenomena which have as yet been noticed, require further consideration and fuller proof. Some remarks have been offered on the incompetent results which are obtained, by the use of barriers consisting of pores of large size, such as stucco plugs, sections 2, 3, 4. It is said however, that in the hands of Mr. Graham these have given some curious results, respecting the rate of diffusion of gases; experiments at once satisfactory and singular.

18. The objections above mentioned, have however, appeared to me so weighty, that I have not made use of such barriers, but resorted to liquids, which for closeness of texture, uniformity of composition, and above all, on account of our accurate knowledge of their habitudes and structure, are much preferable. They also, have given results as curious, but far more satisfactory, and though in the management of them something of that dexterity of manipulation is required which practice alone can confer, yet they are easy of repetition, never failing to give precise and comparable results. They also afford the means of prolonging or hastening the close of an experiment, which at times is invaluable; their action too, is very uniform, for a film of water so thin as to be coloured, acts as well as a mass several inches in depth, but the gases passing through it more rapidly a state of equilibrium on both sides of it is obtained in a few minutes. The following facts will serve as an illustration. Into a tube *b*, which was conoidal at its upper end, a disk of paper *a*, was fastened water tight, and then upon that was poured distilled water till it was about $\frac{1}{8}$ inch deep, the tube was next filled at the pneumatic trough as in the figure with hydrogen gas, which passed into the atmosphere through the paper roof, and the water reposing on it; but though the tube was only $\frac{3}{8}$ inch in diameter, twenty-four hours elapsed, before a column half an inch long of hydrogen, had gone out of it, and in seven days only one inch more. A common glass tumbler was filled with hydrogen gas, at the pneumatic trough, and by the side of it stood a small bottle, the height of which was about $1\frac{3}{4}$ inch, its diameter $1\frac{1}{4}$ inch, and the diameter of its neck $\frac{3}{4}$ of an inch. The atmospheric air in this bottle, being of the same temperature as

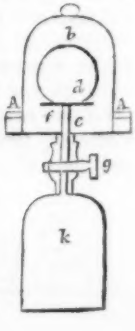




the hydrogen in the tumbler, a finger dipped in water rendered slightly viscid with soap, was lightly passed over its mouth, so as to leave a thin film stretched there, the tumbler of hydrogen being placed over it, as in the figure. In the course of two minutes, the film, instead of being horizontal became convex, and continued to be so until it had swelled into a large spherical bubble, which capped the top of the bottle; in sixteen minutes this had increased so much in size and become so thin, that it was of a dark metallic lustre, and it burst at last by swelling, so as to touch the bottom of the tumbler. During this experiment, the barometer was at 28.8. Thermometer at 66.75. Fah.

19. The rapidity of this action being proportional to the thinness of the film used as a boundary, it is obvious that the duration of an experiment may be managed, by determining beforehand, the thickness of the film through which the gases shall pass. If very thick, the time may be indefinitely long, and if very thin, indefinitely short. Nor need we be limited in reducing the thickness to the greatest extent,for it is found by experiment, that however thin the film may be, it still possesses cohesion enough, and its parts are still so close, that any thing like mechanical straining or leakage cannot take place through it. The first attempts made to ascertain the laws of movement and equilibrium of gases passing through liquid films, were made by stretching those films over the mouths of phials, as here described; subsequently, for several considerations, this arrangement was given up, the horizontal film is at first too thick, it exposes too small a surface to the atmosphere to which it is subjected, and it is not until towards the close of the experiment, that the action becomes at all rapid. Bubbles of water made sufficiently adhesive by a little soap were therefore substituted. One of these filled with any gas, and immersed in an atmosphere of another gas at once exposes a large surface, and by swelling and collapsing allows a free action. There are, however, three circumstances which tend to destroy such bubbles, and against these provision should be carefully made. Mechanical agitations of the surrounding air may be met, by covering the whole arrangement with a glass bell. Evaporation from the surface of the bubble, which reduces its subtance unduly, may be avoided by keeping all the gases under trial, in jars over water, until they are loaded with moisture, and thoroughly wetting the inside of the covering bell; but it is not so easy to prevent that slow motion of the parts of the bubble, which in virtue of the earth's attraction, tends gradually to bring them to the lowest part whilst the walls of it become too thin to bear the weight, and are liable to burst by the expansion of the gases accumulating within.

20. After a number of trials, the following has been found to be the most suitable arrangement for prosecuting these enquiries; it is simple, not easily deranged, and allows of sufficient latitude and change, to suit other experiments. In it a soap bubble may be preserved with certainty, for a time considerably exceeding an hour, and sometimes much longer. As here described, it was used to illustrate the relative passage of hydrogen, oxygen,and nitrogen,through a watery film into atmospheric air. It is represented in section, A A is a small tin saucer, about three inches in diameter and half an inch deep, into it water can be poured, and it also serves as a platform to support a large cupping glass *b*. Through the centre of this tin saucer at *c*, passes a glass pipe *f*, $\frac{1}{8}$ inch in diameter, the upper extremity of which is cemented into a



hole of the same size in a round, thin, piece of copper *d*, which is about half an inch in diameter, the other extremity of the pipe opening into another cupping glass *k*, through a perforation in its top, the communication being capable of being cut off, by means of a cock *g*, the lower cupping glass serves as a support to the whole arrangement when placed upon the shelf of the pneumatic trough. This apparatus is used as follows: The upper cupping glass being taken off the platform, is filled with any gas under trial, as oxygen, and placed aside on the shelf. The lower cupping glass is then filled with water, by depressing it in the trough, and the cock being closed, five hundred measures of hydrogen for instance, are thrown into it. After seeing that the copper plate *d*, is free from moisture, a drop of water rendered slightly viscid by soap is placed upon it, exactly over, where the orifice of the pipe *f* opens. The upper glass containing the oxygen, is now placed upon the little tin saucer platform, as in the figure. The lower glass is next depressed in the trough, and as soon as the cock is opened, a bubble of hydrogen containing five hundred measures expands, the spare oxygen escaping in bubbles from the upper glass, through the water in the saucer, the cock is next closed, and the apparatus placed on the trough shelf, as long as the operator desires the experiment to continue. Keeping that position when the cock is once more open, the gas passes into the lower glass, until the bubble is entirely collapsed, when the cock is again closed, the contents of the bubble being now ready for measurement, or analysis. As the gas passes from the bubble into the lower jar, the water rises from the tin saucer into the cupping glass above, confining the gas that was outside of the bubble; this, by the common mode of manipulation, is to be transferred from the tin platform to the shelf of the trough for inspection.

21. By this apparatus it was found, that one thousand measures of atmospheric air, exposed in a bubble to atmospheric air, in five successive experiments, underwent no change either in volume or composition. The duration of the trials was severally, ten, fifteen, twenty, thirty and sixty minutes, and the uniform result when drawn back into the under cupping glass was one thousand measures exactly, the composition of which was the same as atmospheric air.

22. The thermometer stood at 54° Fah. One thousand measures of hydrogen in the watery film, were subjected to atmospheric air in the upper bell; in five minutes there remained only four hundred and seventy-two. In a second trial, one thousand measures in twenty minutes, became four hundred and thirty-two; and in a third, when the same quantity of gas was confined half an hour, the residue was four hundred and eighty measures.

23. A reverse action ensues, when nitrogen is substituted for hydrogen, the bubble swells, instead of diminishing and the resulting gas measures more. It is to be remarked that after the first five minutes, provided the bubble has been sufficiently thin, there appears to be little or no change in the volume of gas, and in a great many experiments it was found, that motion had ceased when the bubble had increased somewhere between $7\frac{1}{2}$ and 10 per cent. The thermometer standing at 55° Fah. one hundred measures of nitrogen in half an hour became one hundred and seven and a half. In another trial, two hundred measures in the same time, became two hundred and fifteen. Again, two hundred in fifteen minutes, became two hundred and sixteen. The greatest variation from this was in one case, when after an exposure of five hundred measures for five minutes, the bubble was

found to contain five hundred and forty-five measures, or an increase of 9 per cent.

24. Oxygen gas exposed in like manner to atmospheric air, decreased in bulk; thus two hundred and fifty measures in ten minutes, became one hundred and fifty-three, and the like quantity in fifteen minutes, diminished to one hundred and forty-four, which amply proves that the passage of oxygen takes place through water, more rapidly than nitrogen. And upon this fundamental principle, chemical decompositions can be effected; as in the last section, where we have a bubble of nitrogen gas exposed to the atmosphere, the nitrogen outside parts with its oxygen, which, passing through the barrier, unites with the oxygen within.

25. Having thus recognised a variation in the rate of passage of gases through thin films, it becomes a point of investigation, to ascertain how long these motions will be maintained, and under what circumstances a state of equilibrium will ensue. I have already stated, that the condition of rest was simply an identity of composition of the media on both sides the membrane, a law which is rigidly observed by all gases that have yet been tried. Four hundred measures of nitrogen gas, procured by phosphorus, but which by standing over water were found to have gained $3\frac{1}{2}$ per cent. of oxygen were exposed to atmospheric air, in the apparatus above described, for thirty minutes, at the end of that time, there were found four hundred and thirty-two measures in the bubble, of which $15\frac{1}{2}$ per cent. were oxygen. Outside the bubble were ten hundred and seventy measures, which also contained $15\frac{1}{2}$ per cent. of oxygen; thermometer 57° Fah.

26. Two hundred measures of nitrogen, containing the impurity as above, were exposed for thirty minutes in an atmosphere of impure oxygen, which contained nitrogen and carbonic acid, to the amount of $13\frac{1}{4}$ per cent. At the end of that time, three hundred and sixty-one and a fourth measures were found in the bubble, of which 62 per cent. were oxygen; and eleven hundred and forty-four and a half measures were found outside, $62\frac{1}{2}$ per cent. of which were oxygen; thermometer 55° Fah.

27. Two hundred measures of oxygen were exposed to an atmosphere of hydrogen for fifteen minutes, at a temperature of 66° Fah. at the end of that time, two hundred and seven and three fourths were found in the bubble, containing $16\frac{3}{4}$ per cent. of oxygen, and twelve hundred and seventy-three outside, which also contained $16\frac{3}{4}$ per cent. of oxygen.

28. The slower passing gases being thus found to obey a very simple law of equilibrium, attempts were made to ascertain whether such, as carbonic acid, which are very absorbable by water, followed the same law; but after many trials no certain result could be obtained, so rapid was the action. Five hundred measures thus confined, passed out immediately, the bubble collapsing almost as fast as it had been expanded, a tube was therefore prepared, which had a roof of water at one extremity, about half an inch thick and two inches in diameter; beneath this roof five thousand measures of carbonic acid gas were placed, and the arrangement exposed to the atmosphere. In forty-eight hours analysis showed that a trace of carbonic acid still existed in the tube, which when washed off, about two hundred measures of unabsorbable gas remained, consisting of 20.5 oxygen, 79.5 nitrogen; and therefore, atmospheric air. This experiment would thus warrant the conclusion, that gases of any kind will pass a barrier, subject to the same regulations as those that are less absorbable, had this experiment been allowed to continue for a sufficient length of time, there can be no doubt that all the carbonic

acid gas present, would have escaped into the atmosphere, and atmospheric air alone been present on both sides of the barrier.

29. Hence the condition under which motion ceases through a barrier, is identity of chemical composition on both its sides. As gases however, pass with different degrees of velocity through the same liquid, results seemingly anomalous may be obtained, and chemical decomposition may ensue; if water recently boiled, be exposed to the atmosphere, it will be found in a few hours, to have abstracted oxygen and nitrogen gases from it, not in the same proportion, however, that exists in the circumambient air, for the gas found in water contains $\frac{1}{3}$ instead of $\frac{1}{5}$ of oxygen; perhaps in the course of time that richer gas would escape, and its place be taken by common air. We therefore consider this a case in which equilibrium has not ensued, progress only being made toward it, the decomposition and apparent anomaly being only the result of a more ready solubility and rapid passage of one gas. By taking advantage of this, it is possible to obtain from the atmosphere, oxygen of some purity. If a volume of atmospheric air be agitated with boiled water in a close vessel, it will be found that a rapid absorption of its oxygen ensues, whilst but little nitrogen is imprisoned among the pores of the liquid. This gas, by the action of fire, may be driven off from the water, and being subjected to another washing, may be rendered still more pure, by successively washing and rejecting the nitrogen left, a gas so rich in oxygen may be procured, as to be equal to some that is obtained by other processes, as by the action of sulphuric acid on peroxide of manganese. In like manner nitrogen gas of great purity may be obtained, by the action of masses of charcoal. Into five hundred measures of atmospheric air, a piece of charcoal was placed, which had been made red hot and quenched under mercury, without being allowed subsequently to come into contact with the air; in a short time the gas was found to be much reduced in volume, and ultimately there remained two hundred and five measures unabsorbed, containing only 8 per cent. of oxygen. The piece of charcoal being removed into water, gas was rapidly evolved which contained only 3.75 per cent. of oxygen, and the last portions disengaged only 2.8 per cent.

Franklin Institute.

Monthly Conversation Meeting for April.

The Eighth Monthly Conversation Meeting of the season was held at the Hall of the Institute, on the 28th of April.

Mr. George Halloway, of Miamiville, Ohio, exhibited a working model of a press for moulding bricks, together with a sample of the manufactured article, the latter very perfect in its form.

Mr. Franklin Peale explained the construction and operation of a machine for counting specie by means of which one person can arrange in uniform piles several thousand coins in a minute.

Messrs. Curtis and Hand exhibited some very neat samples of Carpenter's rules and Norfolk latches, the former manufactured by Clark & Co., of Brattleboro' Vermont, the latter by Isbell Curtis & Co. Meriden, Conn.

Messrs. H. B. Hall & Co., presented samples of improved patent Razor Strap, manufactured by E. M. Pomeroy, of Wallingford, Connecticut, which are found upon trial to be of superior quality.

Committee on Science and the Arts.

Report on Mr. Abraham Gregg's Steam Boiler.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, a Steam Boiler, invented by Mr. Abraham Gregg, of Warsaw, Genesee County, New York, REPORT:—

That having examined the model and specification of Mr. Gregg, they find the objects proposed by the inventor to be the exposing of large surfaces of metal to the action of the fire, compared with the quantity of water used; and the facility of getting at the interior for the purpose of cleansing the boiler.

The method by which he has proposed to effect the former object is, instead of employing a single cylindrical flue or several pipes to convey the gas through the boiler as in well known forms of steam boilers now in use, to form two concentric flues, the inner one a perfect cylinder, and the outer one having the upper portion suppressed in order to leave room for the escape of that portion of steam which may be generated between the inner and the outer flue.

It is proposed to place the fire beneath the boiler, to act on its inferior surface, that the hot air may return through the outer flue and entering the inner one, pass a third time along the length of the boiler and be discharged into the chimney.

To attain his second object, Mr. Gregg makes only the outer shell of his boiler a fixture, and all those cylinders, or partial cylinders, which constitute the concentric flues and their intermediate spaces, he makes *movable*, so as to be drawn out of each other and out of the exterior shell, somewhat after the manner of the concentric tubes in an optic glass. The spaces for water are left by means of rings, of which eight are used in the construction of this boiler, placed on the inside and riveted near the end of each exterior cylinder, which is to retain the water on the outside of the interior cylinder, which is to come next in the order. Thus each head of Mr. Gregg's boiler instead of a single solid piece of cast iron or other material, is made to consist of four concentric rings in two pairs, forming between each pair a circular joint, necessary to be rendered steam-tight, and giving two distinct water chambers only connected with each other at their upper parts where the outside concentric *flue* is interrupted for the purpose of affording a passage to the steam from the interior water chamber to the induction pipe of the engine.

The committee do not deem it necessary to enter into a detail of the manner in which it is proposed to connect the several concentric parts of this boiler together, as they are satisfied that both the objects proposed are quite as well, if not better, effected by the tubular boilers in common use than by the method above described.

They consider as wholly inadmissible, at least on a large scale, the system of loose joints in the head of a boiler, and they deem the arrangement by which the water in two separate parts of the chamber is kept from direct liquid communication to be fraught with danger whenever the water from any cause becomes low in the boiler.

The difficulty of maintaining an equable temperature throughout the system of concentric cylinders must, they apprehend, be found a most serious obstacle to the preservation of steam joints in the double rings. The delay in cleaning boilers, even when it can be done by simply entering them and

scraping out the sediment, is often of serious disadvantage; but when the joints are to be unpacked, heavy cylinders, often of many tons in weight, to be withdrawn, and after cleansing, restored to their places and the packing renewed, we cannot suppose that any difference in the cleansing will compensate for the complicated operations necessary to be performed in the present instance.

We are, on the contrary, constrained to believe that the fire surface will be less, and the trouble of cleansing greater, than in the common boiler; to which is added the danger above referred to against which they find no provision in the specification, or the model of Mr. Gregg.

By order of the committee.

February 11, 1836. WILLIAM HAMILTON, *Actuary.*

Report on Mr. William Shultz's Spark Arrester.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, a Spark Arrester, invented by Mr. William Shultz, of Philadelphia, REPORT:—

That they have examined the plan of Mr. Shultz for arresting the sparks from locomotive engines and that its principal features and mode of operation are as follows:

As in most other contrivances for this purpose the one now before the committee resorts to the use of the wire gauze for intercepting the sparks.

But instead of having it on the top of the chimney in the form of a bonnet or cap, it is interposed in a horizontal plane near the bottom—a conical enlargement in the chimney being provided at that place to allow a sufficiently extended surface for a free passage of the smoke and heated air.

A small door in the side just above the gauze commands a view of the whole surface of the gauze for the purpose of cleaning, &c. The advantages of this arrangement are evidently three fold. First, in admitting the escape steam to be discharged above the gauze by the pipe passing through it in the middle, thereby avoiding the serious inconvenience of the meshes becoming choked by the combined effect of soot and moisture, which is felt, when the steam is discharged below it. Secondly, in a better disposition of the weight of the apparatus which in the ordinary mode makes the chimney top heavy—and thirdly, in having all within convenient reach of the engineer. Besides the main, there are three considerable flues which are occasionally opened by slides which draw horizontally for that purpose. These flues are on different sides of the chimney passing outside of the sheet, or disk, of gauze and serve to give additional freedom to the passage of heated air and smoke, whilst the fire is starting. In an apparatus of this kind which the inventor stated had been tried on the Germantown road, the enlarged diameter of the chimney was three feet in the clear whilst that of the chimney proper was of the usual size of fifteen inches. The inventor likewise stated to the committee that the experiment was entirely successful so far as a single trial could be depended on. The committee are aware that the principle of placing the gauze below the point at which the escape steam is discharged has been before attempted by putting it in the smoke chamber. The objection to this plan seems to have been a too rapid destruction of the gauze by the heat to which it was exposed—a fate which it is feared in some degree awaits the present invention. But from the facility with which the

gauze can be replaced by removing the upper section of the chimney, the opinion is entertained that this will be found the best arrangement which has yet come to the knowledge of the committee for the accomplishment of this difficult desideratum.

By order of the committee.

March 11, 1836. WILLIAM HAMILTON, *Actuary.*

Mr. Fossard's Manufacture of Prussiates and their application to Dyeing.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, Mr. Felix Fossard's manufacture of Prussiates and their application to Dyeing, REPORT:—

That Mr. Fossard submitted to the committee an apparatus and process for the manufacture of the prussiates of potash and soda, and for dyeing with these salts.

The great improvement in the manufacture of the prussiates is in not subjecting the materials to a higher heat than that which is required to produce these salts. This is effected by a mechanical arrangement which brings every part of the material by turns in contact with the heated sides of the vessel, containing the articles from the calcination of which the prussiate results. Particular directions are given in the specification of Mr. Fossard's patent, as to the proportions of the materials, and the best mode of conducting the whole process, from the mixture of the animal matters and the potash, or soda, to the crystallization of the ferro-prussiate. The apparatus seems well adapted to its purpose. While the committee consider it unnecessary to describe the different parts, they must, in passing, observe, that the ammoniacal, or other incidental, product of the action of heat on the animal matter, are collected to be turned to account by the manufacturer.

Mr. Fossard exhibited to the committee some documents founded on the practice of his process in England, where it is also patented, and going to show considerable gain over the common method of manufacture. He also showed beautiful specimens of crystallized ferro-prussiate of potash, manufactured by this process at Stratford in England.

The committee further examined a drawing of the apparatus for dyeing blue, with the prussiate of potash and a per salt of iron, with specimens of cloths and wool dyed by the process. The dye is proposed to be substituted for indigo, particularly for dyeing coarse cloths or wool.

The cloths are dyed in the piece, and being subjected to pressure during the operation, the dye perfectly penetrates the whole thickness. Mr. Fossard has succeeded in entirely removing the harshness usually produced in the cloth by the prussiate dyeing. The varieties of shade in the specimens of cloth examined by the committee, range from light blue to black.

The committee are not prepared to say that the blue upon the fine cloths had all the richness of an indigo blue, but it is said to wear much better than the latter dye, and the seams of a cloth coat, almost thread bare, showed no whiteness. On this point the patentee submitted testimonials from respectable gentlemen known to the committee, and who had worn cloth dyed by this process. The advantage of this dye will, however, be most perceived in the coarse cloths, where the item of dyeing is a considerable one in the cost of the cloth.

The committee have particularly examined the point, whether the colour imparted to cloth in this process is entirely permanent. They have satisfied

themselves that when due care is taken in washing the cloth, there is nothing which will subsequently be removed by rubbing, or by water. They have also had the testimony of a gentleman well known to them, and who has worn a coat dyed by this process, that no exposure to weather has ever removed any part of the colour, nor has any soil appeared imparted by the cloth, when wet or dry, to the clothing with which it has been in contact. This objection then applies only to careless or defective manipulation, and is by no means a necessary consequence of the use of this dye.

By order of the committee,

May 12, 1836. WILLIAM HAMILTON, *Actuary.*

Mechanics' Register.

AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED IN DECEMBER, 1835.

With Remarks and Exemplifications by the Editor.

1. For a *Hot Air and Cupola Furnace;* Leonidas V. Badger, Portsmouth, Rockingham county, New Hampshire, December 2.

This cupola furnace is to be in the usual form, and the upper part of it, above the brick lining, is to have concentric metallic cylinders, or rather truncated cones, standing four inches apart; the inner cone, at its lower end, being of the same diameter with the brick lining of the furnace body, so that the interior may be in a continuous line from top to bottom. A spiral partition is to run round within the space between the upper cones, leaving a distance of four inches between the coils, thus constituting a circuitous pipe of four inches square. Into the upper opening of this, the pipe from the bellows is to enter, and from the lower part pipes are to proceed down so as to conduct the heated air into chests, or boxes from which the tuyeres open into the furnace.

The body of the furnace, surrounding the brick lining, is likewise to be a double case, with an inch space between them.

The claim is to "the double cylinder at the top of the furnace, forming a circuitous chamber for the air, heating the blast from the flame of the furnace, thereby causing a great saving of fuel and time. Also, I claim the double cylinder to the body of the furnace, preventing the escape of heat by the confined air between the two cylinders."

Various plans analogous to the foregoing, for heating air in cupola furnaces, have been carried into operation both here and in Europe. Of some of them we have particular accounts, of others nothing more than general descriptions; and how far the patentee has been anticipated in his particular mode of effecting his purpose we are not prepared to say. The second part of his claim we think ought to have been omitted, as a double case, with air confined between, to prevent the dissipation of heat, is an arrangement familiar to every man of practical science.

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2. For an improvement in the *Composition of matter, and a Machine for Manufacturing Crayon and Pencil Points;* Guy C. Baldwin, Ticonderoga, Essex county, New York, December 2.

For this composition we are told to take equal quantities of rosin and pitch, with as much shellac as is necessary for strength, and to add to them

"finely pulverized black lead, of sufficient quantity, when melted, to form a soft paste;" then to expose the mixture to a melting heat, and to stir it with a trowel until it becomes soft and yielding. The composition is then to be put into a heated iron mould, and forced through one or more holes of any size required, when it is in a proper form for rolling, by which it acquires a polished surface. The rolls are then to be laid in a straight position, cooled, gauged, and cut into the required lengths.

The foregoing information is succeeded by a "description of the machine," which includes the trowel, the knife, the rubbing board, &c. &c. all of which, of course, are patented, as there is no discrimination between them, nor any thing which can be construed into a claim.

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3. For *Smoothing the Oxide of Iron, Brass, &c.;* Bradford Seymour, Oneida, Utica county, New York, December 2.

We are first instructed how to produce an oxide on the surface of metals, which is to be effected by heating them by any proper means. This oxide is then to be smoothed by holding the surface of the metal against a brush of wire, which may be cylindrical, or of any other suitable shape. We are in conclusion told "that this machine and art is intended to be applied to the manufacturing of an article of sheet iron, similar to the article known as Russia sheet iron."

There is no claim made, and if such a brush had been claimed the claim would have been invalid. Such "scratch brushes" have been used in the lathe for ages, and are well known to workmen; but had the thing been new, the information furnished by the patentee would have fallen far short of fulfilling the requirements of the law.

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4. For *Wheels for Rail Road Cars;* Arundius Tiers, Kensington, Philadelphia county, Pennsylvania, December 2. (See specification.)

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5. For an improvement in *Raising Sunken Vessels;* William Atkinson, and Ebenezer Hale, city of New York, December 2. (See specification.)

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6. For *Water Proof Boots and Shoes;* David Clarkson, city of New York; an alien who has declared his intention to become a citizen of the United States; December 2.

"The improvement for which I solicit letters patent, consists in having a lining to the boot or shoe composed of camel's hair, and lamb's wool, covered with gum shellac and alcohol. The lining is made over the block in the shape of the boot or shoe, then the gum shellac and alcohol are spread over with a brush, and worked in with a hot iron, after which the boot or shoe is formed over the lining in the usual manner, except that the tacks in the bottom are omitted."

It is a common practice to render hats water proof by means of shellac varnish, and the foregoing patent is for applying a similar covering to the feet, but as the patentee uses a lining of camel's hair and lamb's wool, we are at liberty to employ sheep's wool, rabbit's fur, &c. &c. without interfering with his *exclusive privilege.* For ourselves, however, we have no disposition to adopt the one or the other, as either, by confining the perspiration which ought to escape freely, would produce results not only offensive, but injurious.

7. For a *Brake for the Wheels of Cars and other Carriages;* John R. Smith, Port Clinton, Schuylkill county, Pennsylvania, December 2.

This patent is taken for a self-acting brake, and the subject is treated as though such a contrivance had not previously entered into the head of any one. So confident is the patentee of this that he says "I do not deem it necessary to describe very minutely any particular apparatus, as it must vary according to the construction of the car." It will be found, however, that the law requires such a minute description, although it does not compel the patentee to abide literally, but only substantially, by it. The claim is to "*the principle* of acting upon brakes by the contact and motion of the cars, by impeding, or stopping, the propelling power." Now the law does not grant patents for principles, but only for the means by which principles are carried into effect, yet all the information derived from the specification, on this point, is that the apparatus by which the cars are coupled is to be connected by rods, bars, or other contrivances, passing under the cars, and acting upon brakes, when brought into contact by the impeding of the locomotives, or from any other cause. We are also informed as regards common road carriages, that "any fixture on them to produce friction on the wheels, by the tendency carriages have to press forward on the horses, when descending hills, I should deem an invasion of my rights." Were such really the case, the patent law, instead of "promoting the useful arts," would become the means of putting a stop to all further improvement in the means of accomplishing any object which had been previously effected in any way.

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8. For a *Machine for Drilling Rocks;* Aaron H. Vancleve, Stonington, New London county, Connecticut, December 2.

Drills are to be made to slide up and down in a frame adapted to the purpose, and are to be raised by cams upon a horizontal shaft, which is made to revolve by hand. In vol. v, p. 290, of this Journal, a similar machine is described, which was patented by J. W. and C. Post. This machine was made and tried, but was not found to answer the purpose intended; in the one now presented, there is not, any thing to insure its better action. The claim is to "the above described machine, and the arrangement and adaptation of its various parts."

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9. For an improvement in the method of *Making Cast Iron Pipes:* John D. Morris, Kensington, Philadelphia county, Pennsylvania, December 2.

An iron mould is to be made in two pieces, the interior of which has the form intended to be given to the outside of the pipe, and in this respect. resembling the two sides of a flask in which a pipe has been moulded. The core is to be made and managed in the same way as when the pipe is cast in sand. Upon the lower half of the mould there is a lengthening out of one end to sustain a piece for the gate, and sinking head. It is proposed, sometimes to line the mould with a composition of fire clay and sand, provision being made, in this case, for properly forming and smoothing the surface; a groove on the edges of the mould is also to be filled with clay and sand, to cause them to fit closely together.

The claim is to "the two cast-iron pieces as above described, and also the using of a cast-iron mould to be coated over as aforesaid, within which pipes or other castings may be cast without injury to the mould, which will therefore last for a considerable length of time, and from which a great

many castings may be made, without requiring, as in the common method, an entire new mould in every instance."

10. For a *Revolving Cooking Stove;* Henry Stanley, Poultney, Rutland county, Vermont. First patented December 17, 1832. Patent surrendered, and re-issued December 2.

This cooking stove is too well known to need any description, and the decision of the United States Court which led to the surrender of the original patent was published at p. 165 of the last volume of this Journal. The following is the conclusion of the new specification.

"I do not claim the revolving of the top abstractedly, nor any one part of the above described stove, as my invention, separately, and independently of the combination herein claimed; but I do claim as my invention and improvement, the combination of the above described cap, or top plate, in connection with its revolution, and its position in relation to, and resting upon, the circular plate on which it revolves, and the rack or pinion, or other power used to cause the revolution, and the groove and flanch on which, and the centre round which, the cap or top plate turns, and the collars and flues connected as they are with the position of the plates, the fire room and diving flue, as they stand combined and connected with each other in the manner above described, and exhibited in the drawings, or in any other manner substantially the same, and as the whole combination stands connected with the other parts of said stove."

11. For *Weaving Stock Frames;* F. Goodelle and Thomas W. Harvey, Ramapo, Dutchess county, New York, December 2.

These stock frames are to be woven in a power loom, constructed for the purpose. The apparatus is necessarily complex, and does not admit of verbal description. The patent is accompanied by a very perfect engraved representation of it with numerous references. After describing the apparatus, the patentees make seven distinct claims, to those parts of the apparatus by which the loom is adapted to the special purpose to which it is to be applied. Were we to give these claims they would not afford any correct idea of the particular construction of the things claimed; upon a careful examination of them we do not find any thing which does not appear new in the manner, and for the purpose, to which it is applied.

12. For a *Machine for Hulling Clover and other Seeds;* George W. Taylor, Bridgeton, Cumberland county, New Jersey, December 4.

The rubbing is to be effected by revolving, cast-iron disks, the surfaces of which are convex, so that they are in shape like a double convex lens; the surfaces having grooves formed upon them, and which revolve between cast iron cheeks furrowed in like manner, and embrace about two-thirds of the disks, the other third being cut away to allow of the necessary space for the feeding and delivery of the seed. There is to be a feeding hopper above the revolving disks, and other necessary appendages. The claim is to the machine as described.

13. For a *Cook Stove;* Bennington Gill, city of New York, December 9.

This stove is intended principally for the purpose of cooking by means of anthracite, but the fire place may be so constructed as to burn wood, if de-

sired. The bottom plate is to be circular, to stand on feet, and to sustain a square box for the ash pit drawer. Above this is the fire place, which is made conical, its lower end being about seven inches in diameter, its upper about twelve, and its height about seven. This is surmounted by what is called the receiver, consisting of a circular plate fitting on the upper edge of the fire place, having another five inches above it, forming the two, with their rim, a flat cylinder which receives the lower parts of the cooking utensils through openings in the top plate. A plate within the receiver, over the fire, serves to distribute the heat laterally, and there are sliding valves, or dampers, to direct it under any particular vessel. The claim made is to the arrangement of the respective valves, &c. within the receivers. The difference between this stove and some which have been previously made is not very great, and so far as we can judge from the description and drawings, which are by no means defective, we should much prefer one of Stanley's rotary stoves to it, as being less complex, and more convenient.

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14. For a *Machine for Cutting Straw, and Thrashing and Winnowing Grain;* Leonard Marsh, Hartford, Windsor county, Vermont, December 9.

This is a combined machine intended, in general, to cut the straw into lengths, like an ordinary straw cutter, and to thrash the grain from it, after which the grain and straw are to be separated by winnowing, in the usual way. When the grain is to be thrashed only, the cutting knives are to be removed, the thrashing part remaining, to effect that object.

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15. For a *Gentleman's Travelling Dress Hat;* Victor De Braine, city of New York, December 9.

This is to be a kind of hat the crown of which may be flattened down, its sides folding in like the leather of a pair of bellows. A thin metallic hoop is to surround the interior of the crown at its upper, and another at its lower part, and these are to be connected together by hinges, of thin steel, having a joint in the middle, and at its attachment to each hoop. These hinges fold inwards when the crown is depressed. An intermediate hoop is also employed to increase and regulate the fold. The claim is to the particular arrangement described.

It is unfortunate for the American inventor of this hat, that precisely such hats were made and sold in Paris, at least as far back as the year 1833, at which time a friend of ours bought one in the "Place des Victoires," in that city. It is rather too late, therefore, to re-invent the thing in New York.

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16. For an improvement in the *Truss for the cure of relaxation of the Vagina, and prolapsus of the Uterus;* patented by Amos G. Hull, May 7, 1834. John F. Gray, administrator of the estate of Amos G. Hull, December 15.

The description of the improvements made by Mr. Hull in the above named truss, as given by his administrator, is not of a nature to be made known without the drawings which accompany it; we therefore pass it over.

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17. For a *Fire-place and Grate for burning wood or coal;* Charles Lane, Hingham, Plymouth county, Massachusetts, December 15.

The lower bars of this grate are to be set below the level of the hearth, and the air to feed it is to be admitted from without, through an opening regulated by a valve, or dampers. The jambs and back are to form hot air chambers, from which the heated air is to be distributed through tubes; vessels for water are also to be contained within the jambs, the vapour from which is to pass into the room through tubes. There are five distinct claims made, which we do not think it necessary to copy, as they contain little if any thing that is new; let one serve as a sample, "the generators of hot air, and the mode of transmitting it to the room." The whole description is of that general character which does not fulfil the requirements of the patent law; and were this defect cured, most of the things claimed would be found untenable.

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18. For an improvement in the *Machine for Pressing and delivering Bricks;* Ulysses Ward, Washington city, December 15.

This patent is obtained for an improvement upon the brick machine patented by Nathan Sawyer, on the 8th April, 1835, which it is proposed to simplify by dispensing with the combination of wheels for conveying the power to the press, and by certain alterations in the apparatus by which the pressed brick is delivered. These alterations, or improvements, could not be clearly described without the drawings; we are informed that the improvements, are really such, as they have been carried into operation, fairly tested and compared with the original machine.

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19. For a *Spiral Bolt, for Bolting Meal and Flour;* Aretus A. Wilder, Mount Morris, Livingston county, New York, December 15.

A spiral thread is to extend from end to end of the bolt, and from the shaft to the bolting cloth. Upon the outer edge of this thread there is a strip of tough hard wood, to which the bolting cloth is to be nailed; and at the ends the cloth is to be fastened by being received between iron hoops screwed together. The advantages of the spiral thread are set forth as though this was new, but care is taken not to include it in the claim, which is to "the frame, or reel, round which the bolting cloth is put, and the fastenings at the ends." This claim is rather obscure, as the frame or reel would include the whole, a claim which cannot be sustained. As to the "fastening at the ends," any workman, who was at a loss to devise means equally good, without interfering with the present patentee, would not be a *don* at his business.

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20. For a *Machine for cutting or splitting Laths;* Barnabus Langton, Troy, New York, December 15.

A horizontal bench, or frame, is to be made, which may be sixteen feet long and seven wide; and at each end of this there is to be a head-block, against which the laths are to be cut. The cutting is to be made from the edges of boards, sawed of a proper length, there being two cutting knives at each end of the frame. These cutting knives meet in the middle of the board, as the lath is cut, their outer ends working on pins attached to the head-block or frame, and their inner ends on similar pins connected with a sliding bar extending along the middle, and from one end of the frame to the other. The sliding bar is worked backward and forward, horizontally, by a crank motion, so that when the knives at one end are cutting a lath, those at the other are being withdrawn to allow the board to descend

for a new cut. The pieces of board are passed into a slot edgewise, at either end of the frame, and descend by their own gravity, or to a gauge which determines the thickness of the lath. It is proposed sometimes to use a single knife at each end, which knife must in that case, be the whole length of the lath.

The claim made "in the above described machine, is the machine itself, and the manner of cutting lath above specified and described."

Such a claim, we apprehend, must be understood to include not only the combination, but also the several parts as described; in which case it is much too broad, as the cutting of laths from the edges of boards, fed to the knife in a similar way, is not new. In some instances the knives used have formed a very obtuse angle in the middle, so as to cut first at the two ends, and this plan we think much preferable to the jointed knife which is at every instant altering its cutting angle. Still, should the machine before us be preferred, we think that enough of novelty might be pointed out upon which to found a valid claim.

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21. For a *Tobacco Press;* John W. Weems, West River, Anne Arundel county, Maryland, December 15.

There is not the slightest novelty in this press, although such a one may not have been used for pressing tobacco. The piston, or driver, placed horizontally, is a rack into which a pinion works, this pinion being on the shaft of a cog wheel, turned by a pinion on the shaft of a drum, or hand wheel. The hogshead into which the tobacco is to be pressed is rolled on to the frame, or ground sills of the press, one end resting against a head block, and the follower being brought up against the tobacco contained in it.

The claim is to "the before described press, for pressing tobacco and other substances."

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22. For a *Machine for Cleaning Buckwheat;* Daniel T. Laning, Bridgeton, Cumberland county, New Jersey, December 15.

A stationary hollow cylinder is to be made and fixed on a suitable frame, its periphery being in part formed of boards, and in part of woven wire. An axis passing through the centre of this cylinder carries four wings made of plank, which are caused to revolve by means of a whirl placed on the end of the shaft, thereby agitating the buckwheat which is put into the cylinder, and throwing it against the woven wire, through the meshes of which the foreign matter escapes. The claim is to "the said machine."

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23. For *Sharpening Razors, Surgical Instruments, &c.;* William Child, city of Baltimore, December 15.

Nothing can be more vague than the, so called, specification of this patent, which, we suppose, is taken for the application of some kind of hone, or slate, which the patentee has found in a quarry or bed, somewhere; even this, however, is mere conjecture, as will be seen by quoting his own words, which are, that "this discovery consists in applying adhesive or polishing slate for the purpose aforesaid, which slate or matter is composed principally of silica, of alumine, water, oxide of iron, a trace of lime, and a trace of magnesia, its specific gravity 2.6 to 2.8.

"This matter or slate may be used in any form most convenient, either as a hone, or being pulverized into a fine powder, may be placed on common razor straps, &c."

"What I claim as my invention is the application of slate or matter of the character above described, to the sharpening of the instruments and edge tools above described."

This NEW composition of matter was undoubtedly put together a few thousand, and possibly a few million of years, prior to the period when the serpent beguiled eve, and even prior to the ages in which the Saurian monsters were the lords of the land and of the ocean. "Whetstone, slate, or hone," we are told by Bakewell, "is a variety of talcy slate, containing particles of quartz; when these particles are extremely minute, and the slate has a uniform consistence and requisite degrees of hardness, it forms hones of the *best* quality." If the patentee has discovered any hones still *better*, he ought at least to have told us where he had found them, that after the expiration of his *exclusive right* to the sharpening of his razor upon a transition rock, we might enjoy the same privilege in the same degree.

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24. For *Water and other Cisterns;* Alfred Palmer, Syracuse, Onondaga county, New York, December 15.

We are informed that this patent is taken for an improvement upon that of George Tibbet's, dated December 30, 1833, (see p. 25, vol. xiv.) In the present case we shall content ourselves, and probably our readers also, by giving no more than the claim.

"What I claim as my own invention in the mode of constructing cisterns, is the taking out the tubes or curbs, and leaving the cisterns of solid cement or other hard substance, the out and insides being partially smooth and free from the inconvenience of perishable materials, and of the cleaving off of the plastering." For remarks on a similar cistern, see p. 407, last volume, and also in other places too numerous to mention.

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25. For an improvement in *Lamps;* patented October 6th, 1835. Patent surrendered to correct a clerical error, and re-issued December 16, Samuel Rust, city of New York.

The original specification was, it appears, considered by the patentee as defective, and the patent under it was issued by mistake, and contrary to his request. The form of the claim as contained in the corrected description is as follows:

"My improvement does not consist in a *stopple*, or in a *tube*, or in a *cap*, but in the application and combination of a *roller* or of *rollers*, with the said tubes, or sockets, *cap* and *stopple*, in or to the lamp as above set forth, or in any other way or manner that is essentially the same. Or inserting any *roller* or *rollers* into any *tube* or *socket* of any lamp whatever that is made to receive the wick with the said roller or rollers operating and regulating the wick of a lamp on this principle, and for which I request a patent."

We gave a brief description of the contrivance above alluded to at p. 326 of the last volume, to which we refer those who are desirous of obtaining an idea of its nature, which the above claim certainly does not convey.

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26. For a *Door Lock;* John R. and Henry C. Campbell, Charleston, Middlesex county, Massachusetts, December 28.

This is a combination lock, in which certain letters, or figures, are used to regulate the parts upon which the opening of it is dependant. There is nothing new in the principle, and the arrangement is susceptible of indefinite

changes; the modes pointed out by the patentees, are the foundation of their claim to invention, and these we do not think it necessary to particularize.

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27. For a *Steam Gauge Tube for Steam Boilers;* Samuel Raub, Jr., Wilkes Barre, Luzerne county, Pennsylvania, December 28.

This contrivance is to be called a *life saving machine*, and is intended to prevent explosions in steam boilers; the aim and the end proposed are certainly worthy of all praise, but most unfortunately we do not understand the means, or mode of operation, although nothing can be more simple than the contrivance itself, as it consists merely of a tube which is to be secured to the top, and is to reach down thence to the bottom, or nearly to the bottom, of the boiler, which tube is to have openings on its sides, extending up to a point somewhat above the surface of the water. A second tube is to slide closely down within the former, and is to extend above it; when this dips into the water, no steam, we are told, can escape; but when it is raised the steam will pass through the openings of the first, into the second tube and be discharged freely into the atmosphere. "To ensure perfect safety the second tube should always be raised according to a gauge or scale to be ascertained for each boiler." "This is claimed as an improved mode of construction different from those heretofore in use." The next improvement, we suppose, will be to boil the water in an open kettle, from which the steam might reach the atmosphere without being put to the trouble of passing through a tube.

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28. For a *Thrashing machine;* Moses Davenport, Phillips, Somerset county, Maine, December 28.

The general mode of thrashing by a cylinder and concave, is employed in this machine, the concave being placed above the cylinder. The claims made are to a feeding roller with teeth, which takes the unthrashed grain from a feeding apron, and aids in conducting it to the cylinder, and to what is called a separator, which allows the grain to pass through to riddles and fans, whilst the straw is carried off. There is nothing in this machine that requires particular notice.

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29. For a *Machine for renovating and cleaning Feathers;* Edmund Wood, Owego, Tioga county, New York, December 28.

If feathers are not cleaned and renovated, it will not be from the scarcity of machines designed to effect those purposes, the difficulty will be to choose between them, on account of their great resemblance to each other. That before us, is provided with a box, or case, to receive the feathers, having in it revolving beaters to stir them up, and beneath it a steam boiler with a tube leading into it; and in the bottom of this box there are perforations to allow dust to escape. So far, this machine is so much like some others, as to appear to be actually of the same species. There are, however, certain improvements in the dressing of the feathers not before proposed; one to disinfect them, and another to supply them with animal oil. The first is to be accomplished by putting lime and vinegar into the boiler instead of water, and supplying the feathers with the vapour therefrom. This process is rather unchemical, and appears to be put into the description for effect. To supply the feathers with animal oil, should they be deficient in this article, the cloth which is to cover the box is to be imbued with goose grease, deer foot, or other preferred oil, and the feathers as they are agita-

ted and strike against the cloth, are to absorb the requisite dose of this material, to which odoriferous articles may be added. The claims are to the apparatus, and also to the disinfecting and the oiling processes.

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30. For a *Brick Machine;* Benjamin Hamblett, Portland, Cumberland county, Maine, December 28.

The clay is to be mixed in a box by revolving arms or knives, in the manner well known, and from the lower end of this it is to pass out through an opening to be moulded and struck. The apparatus is described at great length, and there are several distinct claims; the machine so nearly resembles some of its predecessors that any attempt at description and comparison, would demand much room, and consume more time than we have to spare. The claims alone would not furnish a correct idea of the things claimed.

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31. For an *Amalgamating Mill to separate Gold from the Ores;* Joseph Curtis, city of New York, December 28.

In this mill or amalgamating apparatus, the aim is to amalgamate the gold by forcing the ore, mixed with water, through mercury, by hydrostatic pressure. The apparatus for this purpose is clearly described and represented in the specifications and drawings. The mercury is to be contained in a cast-iron pot, at the lower part of the apparatus, and an iron tube reaching nearly to the bottom of the pot, rises vertically above it, and is lengthened out by a copper, or other, tube, so as to be about five feet in height. Through this tube, the ore, finely pulverized and mixed with water, is to be fed to the amalgamating pot, into which it passes and rises up through the mercury, by the superincumbent pressure. As it rises it has to pass over and under a number of iron shelves or partitions, which cause it to pass very circuitously before it arrives at the spout through which the earthy matter and water are to escape. To ensure the more perfect distribution of the ore, the feeding tube, with the shelves attached to it below the surface of the mercury, are made to revolve, there being a gudgeon working in a step at the lower end of the tube, and numerous small perforations to allow the ore and water to pass through.

The claim is to "the application of hydrostatic pressure to the passing of ore through a stratum of quicksilver by means of the mechanical combinations set forth in the above described mill, or by any other combination that may be preferred."

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32. For an *Amalgamating Mill to separate Gold from the Ore;* Joseph Curtis, city of New York, December 28.

The apparatus here used is the same with that described under the last patent, but with the addition of the application of heat to the iron pot containing the mercury. The claim is "to the application of heat to the ore in passing through the stratum of quicksilver, by making the fire glide around or beneath the vessel in which the process is carried forward, in the manner aforesaid or in any other manner preferred."

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33. For an *Amalgamating Mill to separate Gold from the Ore;* Joseph Curtis, city of New York, December 28.

There is but very little verbal difference between this and the last specification, both of them differing from the first in the application of heat to the amalgamating pot, and in their having an iron tube leading from the

bottom of the pot, through the fire place; which tube is to become heated to such a degree as will evaporate the mercury, and cause the gold to be deposited within the tube, a process which it is supposed, will be continued by the passing down of fresh portions of the amalgum, and the condensation of the mercurial vapour on its return to the amalgamating vessel.

The claim in this last specification is to "the application of hydrostatic pressure to the passing of ore through a stratum of quicksilver in combination with the application of heat to the ore in passing through the stratum of quicksilver in manner aforesaid, or in any other manner preferred."

We suppose that the patentee could give a good reason for taking three patents for the foregoing process, instead of including the whole in one, although we are unable to perceive it. The last two, in fact, appear to us to be for precisely the same thing.

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35. For a *Combined Cam Apparatus or Press;* Alonzo S. Greenville, Cambridgeport, Middlesex county, Massachusetts, December 30.

This apparatus, as its name indicates acts by a combination of cams, and it is intended to be used wherever heavy weights are to be raised or moved short distances, and also in such presses in which the toggle joint, or similar contrivances, are usually employed. Cams of several different sizes are placed upon the same shaft and operate like eccentrics, upon friction wheels which are likewise of different sizes; the whole to be so graduated as to adapt them to the particular purpose to which they are to be applied; describing its application to a printing press, the patentee says, "In the commencing operation of the press, the larger cam is in contact with the smaller wheel, and the descent of the platten is then, of course, the most rapid; the second and third cams then come successively into contact with their corresponding wheels, the power being thereby progressively increased in any desired proportion."

"What I claim as my invention, and wish to secure by letters patent, is the employment of the combined cam for raising weights and overcoming resistances; operating upon the principle herein set forth. I do not intend, in the construction of the same, to confine or limit myself to the precise mode by which I have exemplified my invention, but to vary the same in any way that I may find convenient, and which is in accordance with the same principle or mode of action. I also claim the particular manner of raising a platten or follower herein described."

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36. For a *Machine for Ironing;* Samuel Swett, Jr. Redfield, Kennebec county, Maine, December 30.

A cylinder, covered with flannel, or some other like substance, is to revolve at one end of the table, and upon this cylinder rests an iron plate, concave beneath, and flat at top, to receive iron heaters, the clothes to be ironed are carried, by means of a "feeder," between the roller and the heated iron which rests upon it, and when passed through the process is complete.

We do not think it necessary to lengthen out our description, as we believe that brevity will be found to correspond best with the history of this invention.

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36. For a *Thrashing Machine;* Amos Hanson, Windham, Cumberland county, Maine, December 30.

This is a machine of the most common construction, and the claim made

is to "the pulleys, bands, and wooden wheels, and the manner of operating the same thereby," a claim about as good as any that could be made where there is nothing upon which to found one.

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37. For a *Mowing and Reaping Machine;* Alexander M. Wilson, Rhinebeck, Duchess county, New York, December 30.

This, like some other mowing machines, is to be driven forward by a horse, and it has on its front a horizontal revolving wheel which carries the cutters by which the mowing, &c. is to be effected. This wheel is caused to rise with the rise of the ground, by the action of small wheels or rollers, and is itself driven by means of a band around a drum on the axle of the large wheels. There are several appendages which it would be in vain to describe without the drawing. The claim is to the fly wheel with its knives or cutters, substantially as described, together with the general arrangement of the apparatus. Similar cutter wheels have been employed, and we do not see any thing in the general construction of this machine likely to insure its operating better than other mowing machines previously patented in this country and in Europe.

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38. For an improvement in the *Escapement for Time Keepers;* James Fulton, Shelby county, Kentucky, December 30.

There are twenty-six figures referred to in the drawings of this improvement. The claims made, are to "the arrangement of two separate locking pallets in such a manner that they will receive the action of the teeth or pins of the scape wheel, by having springs so connected with the pallets, or with arms projecting from their axes, that by the movement of the wings or levers to which the other ends of the springs are attached, or by both, each of the pallets is alternately, in one part of the vibration, held by the pressure of the spring, in a position to come in contact with the teeth of the scape wheel, and in the other part is caused, as soon as relieved from the teeth by the other pallet, to move out of their way."

Specifications of American Patents.

Specification of a patent for an improved mode of raising sunken vessels, &c. Granted to William Atkinson *and* Ebenezer Hale, *city of New York, December 2d,* 1835.

To all whom it may concern, be it known, that we, William Atkinson and Ebenezer Hale of the city, county and state of New York, have invented a new and improved mode of raising sunken vessels, and other articles, from the bottom of rivers, seas, bays, and other waters, and which may also be employed to prevent the sinking of such vessels, or other articles, and that the following is a full and correct description thereof.

We prepare bags which are impervious to air and water, and to them we attach hose, or tubes, properly prepared, and of such length as may be necessary for the intended purpose. The most effectual way of preparing such bags and hose, is by coating canvass, or other cloth of sufficient strength, with caoutchouc, or India rubber, in a manner now well known. The form of the bags may be varied, but the best is that of a globe, as when they are distended by filling them with air, more will be contained under the same bulk than in any other form.

The bags should be properly strengthened by bands of canvass or cordage, and be sunk in the water, and firmly attached to the vessel, or other article to be raised, which may be done by means of a diving bell, or in any other way which the particular circumstances of the case may render convenient.

The hose or tubes, leading to each bag, must be of sufficient length to extend from it to the apparatus by which the bag is to be inflated, which may be on board of a moored vessel, or otherwise. The distending apparatus will consist of a common condensing or force pump, by which the air may be forced through the hose, or tube, so as to distend the bag.

It may be found convenient, and we sometimes intend, to fill the bags before sinking them, proper tackle and blocks being attached to, or passed under the vessel or other article to be raised. The inflating of the bags may in this case be rapidly effected by the use of a large, common bellows. We intend also, to use such bags, so inflated, within the hold, cabin, or other parts of vessels, which, when not wanted, will occupy but little space, and when required, may be easily inflated by a pair of bellows adapted to that purpose. In all cases, suitable air-tight valves or cocks, should be employed, and such other appendages as may be found useful for coupling the inflating apparatus, or otherwise, when securing the air within the bag.

It is not necessary for us to prescribe the size, or number of the bags to be employed: nor indeed would it be possible to do so, without assuming a particular case, but it is manifestly a thing of easy calculation, and one which must be made in every individual instance.

What we claim as our invention, and wish to secure by letters patent, is "the employment of bags rendered impervious to air and water, and furnished with hose or tubes, cock or valves, through which they can be filled with air, after being sunk and properly secured to a vessel, or any other article intended to be raised from the bottom to the surface of any water; or when first distended and afterwards sunk, as herein described. We also claim their use or employment for preventing the sinking of vessels or other articles, as set forth by us."

WILLIAM ATKINSON,
EBENEZER HALE.

Specification of a patent for an improvement in the Wheels of Rail Road Cars. Granted to ARUNDIUS TIERS, *Kensington, Philadelphia county, Pennsylvania, December 2d,* 1835.

To all to whom these presents shall come: Be it known, that I, Arundius Tiers, of the district of Kensington, in the county of Philadelphia, and state of Pennsylvania, have invented a new and useful improvement in the construction of wheels for rail road cars, and that the following is a full and exact description of the construction of said wheel as invented and improved by me. The wheel is to be made of cast iron, with a wrought iron band shrunk upon it, to form the tread of the wheel. The form and shape of the respective parts of the wheels which I most prefer, is exhibited in the drawing.

In the construction of that part of the wheel which is made of cast iron, the flanch A, B, in the accompanying section, is chilled and hardened in the mould as it is cast, in the ordinary way of chill-hardening cast iron. A small rim or flanch C, D, is formed and cast on the inner side, or face

of the wheel; this rim is intended and used to confine the wrought iron band which is afterwards to be put around the wheel. The wrought iron band E, F, is first welded together in the form of a hoop, and then heated until it has expanded sufficiently to pass over the small rim, or flanch, above referred to, when it is allowed to become cool, and to contract upon the wheel as exhibited in the drawing. This wheel possesses all the advantages of a chilled, cast iron flanch, with a wrought iron band or tread, and is therefore deemed to be decidedly preferable to the cast iron wheels with wrought iron flanches, inasmuch as the wrought iron flanches soon wear out, especially on roads that have frequent curves in them. This wheel is also exempt from one of the greatest objections to the common, chilled cast iron wheels, in being free from slits in the hub, the small quantity of metal which requires to be chilled in this wheel allows the wheel to be cast solid in the hub, and renders the precautionary operation of slitting the hub entirely unnecessary. The shape of the band is that of a flat, or oblong square, and hence it may be formed by the ordinary rolls; and consequently, when worn out may be replaced at a small expense.

What I claim as new and as my own invention or discovery, in the above described wheel, and for which I ask an exclusive privilege, is "the manner of constructing wheels with chilled flanches and wrought iron bands, as above described."

ARUNDIUS TIERS.

Practical and Theoretical Mechanics and Chemistry.

Davy's Safety Lamps.

Evidence of Jonathan Pereira, Esq., F. L. S., Chemical Lecturer at the London Hospital, &c.

What is your opinion of Sir Humphrey Davy's lamp, as a security against the effects of carburetted hydrogen gas?—I do not think it is a security, because the lamp will allow the passage of the flame through it.

Will it allow the passage of the flame when suspended in the carburetted hydrogen gas, without motion? I have never seen the flame pass through the wire gauze when the lamp was at rest, and the gas not in motion. Under such circumstances the lamp may be safe, at least I have never seen it explode.

Have you seen it explode under other circumstances? Repeatedly, when the lamp, or the gas, has been in motion. I was accustomed for years to show the Davy-lamp in my lectures, and by certain experiments to demonstrate, as I then thought they did, the security of the lamp. The experiments are those usually shown in the lecture room. I am now convinced they are fallacious. There are three methods mentioned by Sir Humphrey Davy, of proving the safety of the lamp: the first method (mentioned at p. 14, 15, of his work, on the "Safety-lamp for coal-miners,") is to plunge the lamp into an explosive mixture contained in a large vessel; the second method (mentioned at p. 16 of Davy's before-mentioned work,) is to hang the lamp in a large glass receiver, through which a current of explosive gas is made to pass; the third method adopted by Sir Humphrey Davy, was tried on a "blower" in a coal

mine. He held the lamp in this blower, and though the wire-gauze soon became red hot, the flame did not pass until the gauze had reached a welding heat, and began to burn. (This is mentioned at p. 138 of his work.) Of course lecturers in London have no means of exposing it to a blower, and therefore they have usually employed, as class-room experiments, the first two mentioned methods of trying the lamp. I have never found the lamp explode by either of those methods; but, as I have already remarked they are fallacious experiments.

You think the lamp, if exposed to a current of explosive gas, decidedly unsafe? Yes, certainly. I will not say it is absolutely safe when the lamp is not moved, and where there is no current; but under such circumstances, I have never seen it explode. I may perhaps mention in what way I became convinced of the insecurity of it. Mr. Roberts has been employe by me for some years as a manufacturer, &c. of lamps; and on several occasions he told me that he was certain the Davy-lamp was not "a safety-lamp." Although I was aware that Roberts had particularly directed his attention to this subject, and from having been a working miner for many years must have been practically well acquainted with the lamp, yet as he was not accustomed to the niceties requisite in conducting chemical experiments, as I and many others had tried the lamp, and as far as I then knew, it had always been found a security against the passage of flame, I confess I thought Roberts was labouring under an error. At his urgent and repeated request, I ultimately consented to attend at Upton and Roberts' manufactory, to see him prove, if he could, the insecurity of the lamp, though fully persuaded that I should be able to find some fallacy in his experiments. In a few minutes he showed me that flame might be made to pass through a Davy-lamp; but thinking that the lamp he employed might not be perfect, I sent for one which I had repeatedly tried, and which I knew to be a perfect instrument. The flame passed through this also. Subsequently I tried the Davy-lamps of some friends, and in every case they allowed the passage of the flame. I then undertook a series of experiments, the result of which is a firm conviction of the insecurity of the Davy-lamp when in motion, or when placed in a current of explosive gas. I think we may easily comprehend why the flame does not pass when both the gas and the lamp are at rest: it depends on two circumstances, namely, the less heat developed in consequence of less gas burning; and secondly, the carbonic acid formed not being got rid of, checks the passage of the flame through the wire gauze. I think, however, that the latter is the most efficient cause, since the gauze will allow the passage of the flame when it (that is the gauze) is not hot enough to be luminous, so that a great heat is not essential. Now when a Davy-lamp is plunged into a jar of explosive mixture, a quantity of carbonic acid is immediately formed, and this mixing with the unconsumed portion of the explosive mixture, diminishes its combustibility, and therefore its explosive powers. If, on the contrary, you expose the lamp to a current of an explosive mixture, the carbonic acid which is developed is immediately got rid of, (as well as the nitrogen of the portion of atmospheric air employed in carrying on the combustion,) and then the flame passes. A gentle motion of the lamp, combined with the current of the gas, very much promotes the passage of the flame. If, for example, a lamp be held before a jet of gas until it becomes hot (a red heat is not essential), and then gently moved, the flame will pass, and the experiment may be repeated successively a number of times in a minute. Sir Humphrey Davy was well acquainted with this fact, that carbonic acid diminishes the explosive power

of gaseous mixtures. At p. 10 of his work, he says:—"On mixing one part of carbonic acid, or fixed air, with seven parts of an explosive mixture of fire-damp, or one part of azote with six parts, their powers of exploding were destroyed." At p. 32 of his book, Sir Humphrey Davy states that "the consideration of these various facts led me to adopt a form of lamp in which the flame, by being supplied with only a limited quantity of air, should produce such a quantity of azote and carbonic acid as to prevent the explosion of the fire damp, and which, by the nature of its apertures for giving admittance and exit to the air, should be rendered incapable of communicating any explosion to the external air." It is evident, therefore, he endeavored to form a lamp which should be safe from the combined influence of the carbonic acid gas, of the azote or nitrogen gas, and of the wire gauze.

State to the Committee in what way you think the lamp of Messrs. Upton and Roberts is an improvement on that of Sir Humphrey Davy?—There are several points of view under which we may regard it as an improvement. In the first place, it is quite evident that the wire-gauze of the common Davy-lamp partially obstructs or impedes the passage of flame through it; and, therefore, if you employ two layers of wire-gauze, the obstruction is greater than that produced by one. Now in practice two layers of gaze are objectionable; first, because such lamps would give very little light, and secondly, because the gauze would soon become clogged up. But even if these objections could be overcome, there exists a still more weighty one, namely, that the lamp, even with a double layer of wire-gauze, is not secure. I have repeatedly passed flame through lamps of this kind; the experiment occupies a little longer time, because the flame passes less readily through two than one; but it does pass, and therefore such a lamp is insecure. Now in Upton and Robert's lamp only one layer of wire-gauze is employed, and therefore there is little impediment to the light. To prevent the effects of lateral currents, they use a cylinder of glass placed external to the gauze. This is one improvement over the common Davy-lamp; it must be admitted, however, that Davy, at p. 136 of his work, proposed, screens to increase the security of his lamp; but neither the screens of Davy, nor the cylinder of glass employed by Upton and Roberts, would of itself be sufficient to make the lamp secure. Hence, therefore, we come to the next part of the improvement made by Upton and Roberts, and which consists in the manner they admit the external air, or the explosive mixture, to the interior of the lamp. Around the lower part of the lamp is a number of apertures, through which the air passes into a chamber, the ceiling of which consists of layers of wire-gauze. To increase the security of the lamp, any number of these layers may be employed; they are easily taken out and cleaned, and they offer no impediment to the light: whereas in Davy's lamp, any increase in the number of wire-gauzes diminishes the light. This then constitutes a most important improvement. I now pass on to another improvement in this lamp, and which in fact constitutes its superiority to all other safety-lamps that I have seen: when the air or gas has passed through the wire-gauzes, it does not pass immediately into the body of the lamp, but into a second chamber, bounded above by a conical piece of brass, having a central aperture about the size of a sixpence, in the middle of which is the wick; so that all the air passing into the lamp, is brought in contact with the wick, and thus increases the quantity of light evolved; and as the aperture is much smaller than the cavity of the wire-gauze cylinder, the latter cannot fill with flame when introduced into an explosive mixture, so that the flame can never touch the wire-gauze cylinder; and, indeed, be-

tween the flame and the cylinder there is no oxygen to support combustion, as may be shown by its extinguishing a taper; we have, therefore, the very condition Sir Humphrey Davy wanted, since no taper will burn in the space between the flame and the wire-gauze; so that you observe we have three impediments to the lateral passage of the flame, a layer of carbonic acid, a wire-gauze cylinder, and a cylinder of glass. The safety of the bottom consists in any number of wire-gauzes the maker may choose to employ, and therefore if the lamp is not safe it is his fault.

Then how is the top of the lamp secured? It is made safe by layers of wire-gauze, and also by having a contracted aperture to the glass, by which the draught is increased; and all the carbonic acid gas that is formed below, by the combustion of the fire-damp, or of the oil of the lamp, as well as the nitrogen of the atmospheric air, contribute to prevent the combustion of a body in this situation, for if you put a lighted taper here, it is extinguished immediately. Thus then this lamp is made safe at the sides, at the bottom, and at the top, by different methods. If the glass should break, the lamp is then a common Davy-lamp.

Have you made experiments on that lamp in the explosive mixture?—I have submitted this lamp to every experiment I have submitted the Davy-lamp to, and I could never get this to explode; indeed, I have submitted this lamp to a test (oxy-hydrogen gas) which it is not likely to be put to in actual practice.

This lamp then is safe in a draught or current of explosive gas?—Yes, it is perfectly safe in any current of carburetted hydrogen gas, or of this gas and oxygen, or of this gas and air. I have repeatedly tried it, and the flame will not pass. When the explosive mixture was blown in gently, the flame increased in size; if passed in with violence, the flame was extinguished, but no passage of it will take place through the gauze. Lond. Mech. Mag.

On Impact and Collision. By Eaton Hodgkinson.—Mr. Hodgkinson reported to the Section the results of certain experiments made by him on impact and collision, in continuation of those communicated to the Association in the year 1834, on the collision of imperfectly elastic bodies. The results were,

First, That cast-iron beams being impinged upon by certain heavy masses or balls of metal of different kinds, were deflected through the same distance, whatever were the metals used, provided that the weights of the masses were equal.

Secondly, That the impinging masses rebounded after the stroke through the same distances, whatever was the metal of which they were composed, provided that the weights were the same.

Thirdly, That the effect of the masses of different metals impinging upon an iron beam were entirely independent of their elasticities, and were the same as they would give if the impinging masses were inelastic.

Mr. Hodgkinson also gave the result of some interesting experiments on the fracture of wires under different states of tension, from which it appeared that the wire best resisted fracture and impact when it was under the tension of a weight which, being added to that impinging upon it equalled one third of the force that was necessary to break it.

Proceedings Brit. Assoc. &c. Lond. and Ed. Phil. Mag. Jan.

Marine Steam Engine. Extracts from the evidence given by Joshua Field, Esq., of the house of Messrs. Maudslays and Field, before the Select Committee on Steam Navigation to India.

You have had much experience in the manufacture of engines for steam vessels, have you not? Yes, I have.

What do you consider the proper measurement and power of a steamer for a long sea-voyage? The relative proportion of power and tonnage fluctuates between two tons per horse power and four tons per horse power, depending upon the purposes for which the vessel is intended, as well as the length of the voyage.

What do you say as to the measurement? By measurement, I understand tonnage. I have prepared a table which shows at one view the probable speed to be obtained by the application of engines of four different powers in vessels of the same tonnage, also the length of time for which they would be able to carry coal with each power on board. This table, if the committee desire it, I will put in.

AN APPROXIMATE TABLE,

Showing, at one view, the Tonnage of Steam Vessels with the power usually applied to such Vessels; the Number of Days of Twenty-four Hours' Coals they will carry, and the probable Speed they will go with smaller Powers and greater Quantity of Coal.

Tonnage of Vessel.	Power of Engines.	DaysCoal	Power of Engines.	DaysCoal	Power of Engines	DaysCoal	Power of Engines	DaysCoal
252	100	5	80	6¼	60	8¼	40	12
290	100	6	80	7½	60	10	40	15
332	120	7	100	8¼	80	10½	60	14
375	120	8	100	9½	80	12	60	16
425	140	9	120	10½	100	12½	80	15¾
480	140	10	120	11½	100	14	80	16½
534	160	11	140	12½	120	14½	100	17½
597	160	12	140	13½	120	16	100	19
665	200	13	160	16	140	18½	120	22½
736	200	14	160	18½	140	20	120	23½
810	220	15	200	16½	160	20½	140	24
892	220	16	200	17½	160	22	140	26
980	240	17	220	18½	200	20½	160	25½
1,073	240	18	220	19½	200	21½	160	27
	10 miles per hour.		9 miles per hour.		8 miles per hour.		7 miles per hour.	

Will you explain to the Committee the object of this calculation; is it a comparison of tonnage with the consumption of coals and days, and the rates of going? It is to show about how many days' fuel steam vessels will carry with larger and with smaller engines on board, as well as the average speed to be expected from each. Such a table can only be an approximation.

Will you first state what you consider the proper measurement and power of a steamer to go a long sea-voyage? I should recommend a vessel of from 700 to 800 tons, having an engine of 180 or 200 horse-power.

How long would such a vessel run, and at what rate would she go? She would carry coal for 14 or 15 days, and have a speed, in still water, of 9

or 10 miles per hour, and would realise in all weathers at sea, an average of 8 miles while under weigh.

What is the greatest proportion in tonnage and power for a steamer going a long voyage? The greatest proportion of tonnage for vessels going long voyages may be stated at 4 tons per horse-power. For short sea-voyages 3 tons per horse-power; and for river vessels, as Margate or Gravesend, 2 tons per horse-power.

What results does the power give to a vessel of the same tonnage with different powers as to the rate of going? Great power in small vessels gives great speed, but they carry a small quantity of coal and are soon exhausted, while larger vessels being able to carry a greater quantity of coals, work longer and perform greater distances.

Then you draw this inference—the longer the voyage the less the speed? The smaller the power the greater capacity there is left for coal, and, therefore, the greater number of days' coal it would carry.

And the less speed? And less speed, having less power.

And the smaller proportion of power would, of course, consume less fuel in an equal time? Exactly so.

Would not the greatest proportion of power consume the least fuel in equal distances? Against winds or tides it is so, but in calms and fair winds it is not.

What is the greatest distance you suppose a sea-going steamer to run without changing? The same steamer should not go more than 2,000 or 3,000 miles without a relay, or time to put the machinery in order.

Does that also include without taking in coals? A voyage of 2,000 or 3,000 miles may be performed in one stage, but it would be desirable on every account to divide it and take less coal.

What is the greatest distance she would go without coming to a station to take in fresh coals? The distance is limited only by the quantity of coal she can carry.

What is the greatest distance you think a steamer could go without taking in fresh coals? The greatest distance I have known a steamer to perform was the Enterprize, on her voyage to the Cape, in which she carried 37 days' coal.

With continued steaming, do you mean? Yes; she steamed 34 days, and had three days coal left.

Do you mean steaming day and night? Yes.

Besides the coal, is it not necessary to give the engines rest? It is; and the more frequently they can be stopped to clean and adjust, the better they will perform.

Then your observation must be supposed to apply to both? Yes.

Lond. Mech. Mag.

On the immersion of Copper for Bolts and Ship Sheathing in Muriatic Acid, as a test of its Durability. *By* DAVID MUSHET, ESQ.—The durability of copper for bolts and ship sheathing being an object of great national importance, and as there is no better test of its resistance to waste, than immersion in muriatic acid, the following experiments, made thirteen years ago, will, it is hoped, be found not uninteresting.

Small quantities, presenting nearly equal surfaces of each of the kinds of copper described in my last communication, namely, pure shotted copper

of the quality from which brass is made, and shots obtained from unrefined copper, were separately immersed in equal weights of muriatic acid. The immersion having been continued for 48 hours, the acid was poured off, and the copper washed repeatedly, and thoroughly dried. The pure copper had lost at the rate of 5½ grains in 100. But the unrefined copper, on being weighed, seemed to have gained half a grain; so that either a mistake must have been made in the weighing, or else a portion of unexpelled moisture had remained in the porous flakes of the copper.

Six ounces of unrefined copper were mixed with three times their bulk of charcoal, and exposed for six hours to a high heat of cementation much beyond what in the absence of the cementation would have sufficed to melt the copper. The flakes of copper were found surrounded by the charcoal, welded together without fusion, and soft and extremely flexible. Six ounces of the pure copper shots were treated in a similar manner, but the result was so far different that no adhesion of the masses had taken place, and the only perceptible change was a slight cracking or bursting upon the surface of the spheroids, which may be considered as a prelude to fusion. Both results were melted down with charcoal and run into iron moulds. The unrefined copper, when cold, was the strongest and softest; a bar of it, about ⅜ths of an inch thick, cut easily across with a knife, and in colour and general appearance it very nearly resembled Swedish copper. Another piece was flattened out thin when cold for the purpose of immersion in the muriatic acid. The pure copper was melted in rather a higher degree of heat, and although not teemed until it had assumed a creamy surface, and the crucible had fallen to a low red temperature, it was crystalized throughout the whole fracture. The surface and the fracture of this copper were of a red colour; the body weak, and tearing with facility into pieces. Fragments for immersion were cut off and flattened.

The following specimens were then placed separately in muriatic acid.

No. 1, Pure copper, cut off with a chisel, ...	53 grains
2, Ditto, flattened, ...	30 —
3, Unrefined copper, cut off with a knife . .	39½ —
4, Ditto, flattened, in which stuck a minute portion of the knife, . .	45 —

On the morning of the third day the following remarks were made upon their respective solutions:

No. 1, Light green colour, very transparent when dashed against the sides of the glass. No. 2, equally transparent, but the green was brownish and not so decidedly cupreous. After continuing the immersion for 48 hours longer, the acid was poured off and the specimens were well washed and dried.

No. 1, That weighed 53 grains, now weighed . .	39½ grains.
Loss 13½ grains, equal to 25.4 per cent.	
No. 2, That weighed 30 grains, now weighed .	11½ —
Loss 18½ grains. Equal to 61.2 per cent.	
No. 3, Unrefined copper flattened, 39½ grains, now weighed, ...	19 grains
Loss 20½ grains. Equal to 50 per cent.	
No. 4, Unrefined copper bar, 42 grains, now weighed,	38½ —
Loss 3½ grains. Equal to 8.33 per cent.	

It would appear from this experiment that the unrefined copper resists

waste in the muriatic acid, in the same way, and to nearly the same extent, as in the cementation with lime mentioned in my last previous paper.

In corroboration of this fact, we may take the following abstract of another series of experiments, wherein the specimens were weighed three times, at intervals of 48 hours between each weighing.

Unrefined copper,	1st immersion, lost,	. . .	15 per cent.
Ditto,	2nd	ditto	$8\frac{3}{10}$ —
Ditto,	3rd	ditto	6 —
			$29\frac{3}{10}$
Pure copper,	1st immersion, lost	. . . .	25.4 per cent.
Ditto,	2nd	ditto	9.7 —
Ditto,	3rd	ditto	11.1 —
			46.2

In favour of the unrefined copper, principally containing tin,—16.9 per cent. Two pieces of copper, the one pure, the other unrefined, were immersed, under similar circumstances, for seven days. The unrefined copper lost 17 per cent., and the pure copper 45 per cent. To ascertain whether the greater indestructibility was owing to the tin which remained in the unrefined copper, I formed a bar of alloy as follows:

Pure copper . . .	2880 grains
Block tin . .	84 —

a proportion of tin about equal to 3 per cent. A piece from this bar weighing about 183 grains was exposed for seven days in muriatic acid, at the end of which time it was found to have lost 30 grains, or $16\frac{4}{10}$ per cent. The unrefined copper, above mentioned, lost in the same time and under similar circumstances, 17 per cent., which is a striking correspondence. The same piece of tin alloy, at the end of five weeks, was found to have lost in all 76 grains, or $38\frac{1}{2}$ per cent. Pure copper by the foregoing results lost in seven days' immersion 46.2 and 45 per cent.

In the first instance I was inclined to attribute the indestructibility of the unrefined copper in the acid, partly to the effects of the charcoal in the cementation, seeing that the effect produced by that operation was much greater upon unrefined than upon pure copper. Whatever advantages may belong to the proper use of charcoal in the reduction and cementation of copper (and I consider them not unimportant), the addition of a small portion of tin will be sufficient to account for the superior resistance to waste which this alloy presents in the muriatic acid, over that of the common refined copper of this country. This incapacity to rapid oxidation which is presented by the alloy of tin with copper, suggests many useful hints to the artists and the manufacturers, of which advantage has already been taken in forming ship-sheathing and other articles.

Lond. and Edin. Phil. Mag.

Progress of Physical Science.

Experimental researches in Electricity. Tenth Series. By Michael Faraday, *D. C. L. F. R. S., &c. &c.* [*From Phil. Trans.* 1835, *Part. II.*]*

The subjects embraced are, on an improved form of the Voltaic Battery,

* Received by the Franklin Institute, through the kindness of the author.

and some practical results respecting the construction and use of the battery.

Mr. Faraday has previously shown that the chemical forces in the battery are two fold, one local and producing no useful effect, the other transferred and constituting the electrical current in the instrument. By ascertaining the quantity of zinc dissolved, compared with the decomposition produced, in a volta-electrometer, the ratio of the two effects just referred to, may be determined.

In a battery of zinc plates, enclosed entirely by platinum ones, which do not touch metallically, and excited by dilute sulphuric acid, there would be no local action without transfer.

If the surrounding metal be copper, and the exciting fluid dilute nitro-sulphuric acid, a very slight discharge takes place between the adjacent coppers, especially when the circuit is completed. The theory just stated induced the construction of a battery in which a thickness of paper was used to prevent metallic contact, and thus Professor Faraday was led to the re-invention of Doct. Hare's galvanic deflagrator. To the merits of this apparatus, and of its mechanical arrangements, Prof. Faraday does full justice, as full as if it had first originated with himself, while he refers the entire credit to its author Prof. Hare.

A deflagrator of forty pairs of three inch square plates, was compared with a battery of forty pairs of four inch plates of the ordinary form with double copper plates, insulated, and proved to be its equal in igniting platinum wire, the discharge between charcoal points, the shock, &c. The power of the deflagrator diminished most rapidly, because but one seventh of the quantity of acid liquid was required to excite it, the solutions in its trough and in the cells of the other battery being of the same strength.

To compare the two batteries, the amount of zinc dissolved for each equivalent of water decomposed in the volta-electrometer, was ascertained. Three acids were tried, sulphuric, nitric and muriatic. One cubic inch of the first dissolved 486 grs. of zinc, of the second 150 grs. and of the third 108 grains.

A mixture of 200 parts, by bulk, of water, $4\frac{1}{2}$ of sulphuric acid, and 4 of nitric acid, was applied to the deflagrator before referred to, and to four troughs having plates of the size and construction before stated. One equivalent of water in the volta-electrometer, was decomposed for each 2 to $2\frac{1}{2}$ equivalents of zinc dissolved from each plate of the deflagrator, while 3.54 equivalents were required from each plate of the common battery, for the same effect.

Twenty pairs of four inch plates in a deflagrator and twenty of the same size in a common battery, gave respectively 3.7 and 5.5 equivalents of zinc from each plate for the same effect. And with ten pairs, 6.76 and 15.5 equivalents, respectively, for the deflagrator and common trough.

Prof. Faraday remarks:—

"1131. No doubt, therefore, can remain of the equality or even the great superiority of this form of voltaic battery, over the best previously in use, namely, that with double coppers, in which the cells are insulated. The insulation of the coppers may therefore be dispensed with; and it is that circumstance which principally admits of such other alterations in the construction of the trough as give it its practical advantages.

"1132. The advantages of this form of trough are very numerous and great. 1. It is exceedingly compact, for 100 pairs of plates need not occupy a trough of more than three feet in length. 2. By Dr. Hare's plan of making the trough turn upon copper pivots which rest upon copper bearings, the latter afforded *fixed* terminations, and these

I have found it very convenient to connect with two cups of mercury, fastened in the front of the stand of the instrument. These fixed terminations give the great advantage of arranging an apparatus to be used in connexion with the battery *before* the latter is put into action. 3. The trough is put into readiness for use in an instant, a single jug of dilute acid being sufficient for the charge of 100 pairs of four inch plates. 4. On making the trough pass through a quarter of a revolution, it becomes active, and the great advantage is obtained of procuring for the experiment the effect of the *first contact* of the zinc and acid, which is twice or sometimes even thrice that which the battery can produce a minute or two after. 5. When the experiment is completed, the acid can be at once poured from between the plates, so that the battery is never left to waste during an unconnected state of its extremities; the acid is not unnecessarily exhausted; the zinc is not uselessly consumed: and, besides avoiding these evils, the charge is mixed and rendered uniform, which produces a great and good result, and, upon proceeding to a second experiment, the important effect of *first contact* is again obtained. 6. The saving of zinc is very great. It is not merely that whilst in action, the zinc performs more voltaic duty, but *all* the destruction which takes place with the ordinary forms of battery between the experiments is prevented. This saving is of such extent, that I estimate the zinc in the new form of battery to be thrice as effective as that in the ordinary form. 7. The importance of this saving of metal is not merely that the value of the zinc is saved, but that the battery is much lighter and more manageable; and also that the surfaces of the zinc and copper plates may be brought much nearer to each other when the battery is constructed, and remain so until it is worn out: the latter is a very important advantage. 8. Again, as in consequence of the saving, thinner plates will perform the duty of thick ones, rolled zinc may be used; and I have found rolled zinc superior to cast zinc in action; a superiority which I incline to attribute to its greater purity. 9. Another advantage is obtained in the economy of the acid used, which is proportionate to the diminution of the zinc dissolved. 10. The acid also is more easily exhausted, and is in such small quantity that there is never any occasion to return an old charge into use. Such old acid, while out of use, often dissolves portions of copper from the black flocculi usually mingled with it, which are derived from the zinc; now any portion of copper in solution in the charge does great harm, because, by the *local* action of the acid and zinc, it tends to precipitate upon the latter, and diminish its voltaic efficacy. 11. By using a due mixture of nitric and sulphuric acid for the charge, no gas is evolved from the troughs; so that a battery of several hundred pairs of plates may, without inconvenience, be close to the experimenter. 12. If, during a series of experiments, the acid become exhausted it can be withdrawn, and re-placed by other acid with the utmost facility; and after the experiments are concluded, the great advantage of easily washing the plates is at command. And it appears to me, that in place of making, under different circumstances, mutual sacrifices of comfort, power and economy, to obtain a desired end, all are at once obtained by Dr. Hare's form of trough.'"*

The effects of the following circumstances are examined by Prof. Faraday under the new light thrown by his researches.

1. *Nature and Strength of Acid.* Nitric acid evolved no hydrogen, muriatic acid but little, and sulphuric acid most. They gave respectively for the equivalent of water decomposed, 1.85 eqs. of zinc for each plate, 3.8 eqs. and 4.66 eqs. by a mixture of 1 of acid to 200 parts of water. By adding to the mixture of water and sulphuric acid in proportions just referred to, 4 of nitric acid, the consumption of each zinc plate was reduced to 2.786 for each equivalent of water; 8 of nitric acid gave 2.26 eqs.; 200 water, 16 muriatic acid, and 6 nitric acid gave 2.11 eqs. per plate. This effect does not depend upon the strength of the acid solutions, the results being stated in equivalents.

2. *Uniformity in the strength of the charge*, is of great importance.

* A practical difficulty suggested by Prof. Faraday, of making a wooden trough tight under the frequent alterations of dryness and moisture, is entirely overcome by using a coating of cement in the interior as in the trough made by Dr. Hare. Cement duly applied will render unnecessary the glass sides proposed by Prof. Faraday, to prevent discharges from the edges of the plates. B

3. *Purity of the zinc* is of great importance, its impurities making the action of the battery local.

4. *Foulness of the zinc plates*, interferes materially with the action of the battery. No old charge containing copper should be used.

5. *New and Old Plates.* The former are much the most efficacious. But after a few immersions the power of rolled zinc plates becomes nearly constant. This is not the case with cast zinc plates.

6. *Vicinity of the Copper and Zinc.* When the plates are at a less distance the facility of transference is increased. The intensity and quantity of the transferred current, are both increased for a given consumption of zinc.

7. *First immersion of the Plates.* This effect, independently of the newness of the plates, is produced by the mixture of the acid in the charge with that which has been neutralized. Hare's form of trough secures this advantage.

8. *Number of Plates.* The most advantageous number depends, mainly, on the resistance to be overcome in the decomposition, but the number admits, in any given case, of a maximum.

9. *Large or Small Plates.* The use of them will depend upon the facility of the transfer of electricity. If the most advantageous number is found, additions of zinc should be made to the size. Increase of size will raise the most advantageous number.

10. *Simultaneous decompositions.* When the number of plates exceeds the most advantageous number, more than one decomposition may be made with advantage.

The conducting power of the body to be decomposed, of course, materially modifies the results obtained. The enlargement and proximity of the poles, and conducting power of the liquid, should be particularly attended to in the construction of the volta-electrometer.

Recent Researches on Heat. M. Melloni's Researches.—Though the "thermo-multiplier" of M. Melloni has now been for several years before the scientific world, it is not yet perhaps so generally known to experimenters as it deserves to be. We shall deem it, therefore, not inappropriate to the nature of this article, to state briefly its principle.

The essential part of it consists in a great number of pairs of small slips of antimony and bismuth soldered together, and combined in one case, so as to have their galvanic action excited by the application of heat. This thermo-electric effect is indicated and measured by its influence on a magnetic needle, placed below, and arranged as a galvanometer, by having many coils of wire passed round it, the wires communicating with the thermo-electric combination; the effect is increased in proportion to the number of pairs of plates. Thus the *galvanic* action on the *needle* is the measure of the amount of *heat* affecting the metallic combination; and the important and valuable part of the contrivance is, that degrees of heat, so small as to be quite insensible to the most delicate thermometers, are *multiplied*, as it were, by the multiplication of the number of pairs of metal plates, and thus produce a sensible effect on the galvanometer needle. The skill of artists has been exercised in reducing them to small dimensions. M. Gourjon of Paris, has succeeded in bringing them into so small a compass, that the end of the case which is exposed to the heat, is not greater than the section of the bulb of an ordinary thermometer.

An instrument so far surpassing all formerly known in the sensibility of its indications, has, in the hands of its distinguished inventor, led to a series of results equally new and remarkable. A brief summary of some of the chief of them is as follows:

Radiant heat passes directly, in greater or less quantity, through certain kinds of solid and liquid bodies. This class of bodies does not precisely include those which are transparent, since some which are opaque, or very little transparent, are the most "diathermanous*," that is, transparent, as it were, to *heat*. This term is one which M. Melloni has introduced as descriptive of the characteristic in question, and which we shall continue to use.

He concludes, in general, that there exist different species of heating rays; and that all these different kinds are emitted simultaneously from luminous hot bodies; though in different proportions from different sources, certain of them are entirely wanting in non-luminous hot bodies.

Rock-salt, cut into plates, and successively exposed to the radiations from different sources, transmits in all cases the same proportion of heat. Plates of any other diathermanous substance, under the same circumstances, transmit a less proportion of heat as the temperature of the source is less elevated; but the differences between one substance and another in this respect, diminish as the plate is of less thickness; whence it follows (according to M. Melloni) that the calorific rays from different sources are intercepted in a greater or less degree, not at the *surface*, or in virtue of an absorbing power which varies with the intensity, but in the *interior* of the plate, by *a peculiar absorptive force, which is analagous to that of coloured media for particular rays of light.*

M. Melloni advances several theoretical views in support of this analogy. He remarks, in general, that there is but one substance (*viz.* rock-salt) of all he has tried, which is transparent and uncoloured, and acts really in the same manner both on the rays of light and of heat. All others, though they allow all rays of light to pass indifferently, yet absorb certain rays of heat and transmit others. We thus recognise, by means of these bodies, a true distinction in heat corresponding to that of colour in light.

The colouring matter of transparent media always diminishes more or less their diathermanous properties, but gives them no peculiar property of stopping, by preference, any particular species of heating rays. It operates upon the transmission of radiant heat, as *brown* colouring matter (a smoked glass for instance) does upon light; that is, has only a general diminishing power on the intensity. There seems to be, however, an exception in regard to certain glasses coloured with green and with opaque black; but these two kinds of colouring matter only appear to act in modifying the quality of the diathermanous property.

Glass intercepts wholly certain species of heating rays, including all those which come from bodies below luminosity; hence, in this last case, no refraction by prisms or lenses has ever been effected for such rays of heat. With rock-salt, however, the case is different; and it is unquestionably the most singular and important of the facts elicited by Melloni, that simple heat is not merely transmitted through rock-salt, but absolutely *refracted* by it. He determined this both by a lens, and still more remarkably, by a prism of that substance.

With the prism interposed in the path of the rays coming from the source

* From the Greek, διὰ, *through;* and θερμαίνω, *to feel heat.*

of heat, the effect was no longer transmitted in a straight line, but made to undergo a considerable deviation by the action of the prism. This was observed to take place in different degrees, according to the nature of the source of heat. The greatest deviation took place when the flame of a lamp was employed; the next was incandescent platinum; the next with copper, at 390° centig., and when a vessel of boiling water was substituted, the effect was found too feeble to allow of any comparison with the other cases.

However, when the rock-salt was cut in the form of a lens, the concentration of the rays, even from boiling water, was sufficient to give a decided proof of their being really brought to a focus.

Questions relating to the *transmission* of radiant heat through different media, are those which have formed the principal subject of M. Melloni's inquiries. But he has also, in one instance, directed his attention to the equally curious and important question, of the relation of the state of the *surfaces and colour* of bodies to heat. The instance referred to is an examination of the *combination* of the effect of a *screen* with that of *surfaces*, the very same, in fact, which constitutes the experiment first proposed and tried by Mr. Powell, and published in the *Phil. Trans.* for 1825. This fundamental experiment M. Melloni has repeated, and has completely verified it with his extremely accurate apparatus; a confirmation the more valuable, as some previous experimenters, since the date of the publication of the original investigation, seem to have overlooked it. It decisively proves that that portion of the heat from a flame, which passes through a glass screen, is *also* distinguished from the part which is intercepted, by the additional characteristic of affecting a *black and a white* surface in a *different ratio*. This is an inquiry eminently deserving to be followed up by the same method, and to be extended to a long series of different sorts of coating applied to the thermometer or thermo-multiplier.

Polarization of Heat. Professor Forbes.—M. Melloni failed in obtaining any detection of the effects due to the *polarization of heat*, which had been originally stated by M. Berard, though subsequent inquirers had been unable to discover any traces of it.

That zealous and highly-talented experimentalist, Professor Forbes of Edinburgh, here took up the subject. We believe we may say he was the first to introduce the use of Melloni's instrument into Great Britain. He has certainly employed it with signal success. Of such delicate inquiries as those respecting polarization, involving, in fact, complicated arrangements, which could hardly be made intelligible without lengthened details, it would not be possible to speak, in so rapid a sketch as the present, in a way to do them justice. But we must mention, however briefly and imperfectly, the valuable conclusion to which Professor Forbes's labours have led. In an elaborate and masterly paper in the *Edin. Trans.* (vol. xiii.), he has detailed these important researches. The analogies afforded by the polarization of light, led him to expect the most probable method of succeeding in the use of piles of mica; and the result fully justified his expectations.

Two piles of plates of mica were placed obliquely in the path of the rays, so that the inclination was that of the angle requisite for polarization. In such an arrangement, it is well known that in one position of the second pile all light is stopped. The same was found to be true of heat; not only from flame, but even from non-luminous sources. This was not all; as in light, the interposition of a plate of crystal between the two parts of the appara

tus just described, *restores* or is said to *depolarize*, the light, so it was found to do with heat. On the principles of the undulatory theory this is explicable, and even subject to calculation in regard to light: by showing that a similar calculation will apply, Professor Forbes has rendered it in the highest degree probable that the same theory will hold good for heat; and has even pointed out the principle for calculating the lengths of the undulations necessary to be supposed, which he shows will be *greater* than those for light. This exactly accords with Melloni's result of their being less refrangible. Lond. Mag. Pop. Sc., April.

Keith Medal to Professor Forbes. The Council of the Royal Society of Edinburgh, have awarded this medal to Prof. Forbes, for his experiments demonstrating the polarization of light. The Vice President, in his address on the delivery of the medal, announces that Prof. Forbes has succeeded in producing the circular polarization of heat, the first public announcement of this new result. Ibid, Adress of Vice Pres. Doct. Hope, &c.

On the Prismatic Decomposition of Electrical Light. By Prof. WHEATSTONE. The following is a brief notice of the principle results stated in this communication: 1. The spectrum of the electro-magnetic spark taken from mercury consists of seven definite rays only, separated by dark intervals from each other; these visible rays are two orange lines close together, a bright green line, two bluish green lines near each other, a very bright purple line, and lastly, a violet line. The observations were made with a telescope furnished with a measuring apparatus; and to ensure the appearance of the spark invariably in the same place, an appropriate modification of the electro-magnet was employed. 2. The spark taken in the same manner from zinc, cadmium, tin, bismuth, and lead, in the melted state, gives similar results; but the number, position, and colours of the lines vary in each case; the appearances are so different, that, by this mode of examination, the metals may be readily distinguished from each other. A table accompanied the paper, showing the position and colour of the lines in the various metals used. The spectra of zinc and cadmium are characterized by the presence of a red line in each, which occurs in neither of the other metals. 3. When the spark of a voltaic pile is taken from the same metals still in the melted state, precisely the same appearances are presented. 4. The voltaic spark from mercury was taken successively, in the ordinary vacuum of the air-pump, in the Torricellian vacuum, in carbonic acid gas, &c., and the same results were obtained as when the experiment was performed in the air or in oxygen gas. The light, therefore, does not arise from the combustion of the metal. Professor Wheatstone also examined, by the prism, the light which accompanies the ordinary combustion of the metals in oxygen gas and by other means, and found the appearances totally dissimilar to the above. 5. Fraunhofer having found that the ordinary electric spark examined by a prism presented a spectrum crossed by numerous bright lines, Professor Wheatstone examined the phenomena in different metals, and found that these bright lines differ in number and position in every different metal employed. When the spark is taken between balls of dissimilar metals, the lines appertaining to both are simultaneously seen. 6. The peculiar phenomena observed in the voltaic spark taken between different metallic wires connected with a powerful battery were then described, and the paper concluded with a review of the various theories which have been advanced to explain the origin of electric

light. Professor Wheatstone infers from his researches, that electric light results from the volatilization and ignition (not combustion) of the ponderable matter of the conductor itself; a conclusion closely resembling that arrived at by Fusinieri from his experiments on the transportation of ponderable matter in electric discharges. Trans. Brit. Assoc. Lond. and Edin. Phil. Mag.

Kater's Portable Altitude and Azimuth Circle. An account of the performance of a small circle of this kind in the hands of the inventor, is given by Mr. Galbraith. The arch is of but three inches radius. By eight observations the latitude of Capt. Kater's house was determined within about 4.8 seconds of what was considered to be the true latitude, having been obtained by more powerful instruments. Mr. Galbraith speaks of a six inch circle of his own, with a telescope magnifying about twenty times and with three verniers to each of the circles. The level is divided to three seconds. Accounts of the satisfactory performance of his instrument are given. Jameson's Journal

Supposed discovery of a new small Planet. This discovery M. Cacciatore, director of the Observatory at Palermo, supposes he has made. He has not as yet succeeded in establishing it definitively. Ibid.

Heat conveyed by Springs. Professor Bishoff gives a number of examples in which the temperature of the interior of the earth is brought to the surface by springs, and others in which, taking their rise in cold situations, the springs bring with them to a considerable distance the low temperature of their origin. Thirteen fresh water springs near the glaciers of the Tyrolese Alps, and in the limit of their snows, had a temperature from 36¼° to 43¼° Fah. Some fresh water springs at the foot of the upper glacier near Grindelwald in Switzerland, had a temperature of between 37½° and 38°. The springs on St. Gothard 3587 feet above the level of the sea, were found by Wahlenberg and Van Buch, to have a temperature of 37½°

On the contrary, four springs at the foot of the Great Eiger in Switzerland, had only a temperature of 42¾°. Van Buch found a spring near Neufchatel of which the temperature was only 40½°, while the neighbouring springs were from 50° to 50½°. Ibid.

Relative level of Caspian Sea and of the Ocean. The supposed existence of a region of dry land 18,000 square leagues in area, surrounding the Caspian Sea, and below the mean level of the ocean, has naturally excited the most lively curiosity. The fact was regarded for twenty years as established by a series of barometrical measurements made in 1811 by Professors Engelhardt and Parrot. The difference of level which these travellers assigned to the Caspian and the Black Seas amounted to about 350 feet. But Professor Parrot, having revisited the tract in 1829 and 30, soon found reason to doubt the accuracy of his former conclusions. He learnt that some Russian engineers had ascertained by careful measurements that the Don, at the place called Katschalinsk, where it is only sixty wersts distant from the Wolga, is 130 Paris feet *higher* than the latter river, and as the Don flows with much greater rapidity to the Black Sea than the Wolga does to the Caspian, the difference of level between the two seas, if any, must be considerably less than 130 feet. Parrot accordingly made a series of levellings from the mouth of the Walga to Zarytzin, 400 wersts up its course, and from the mouth of the Don to the like distance; and these observations gave as a result that the mouth of the Don was between three and four feet *lower* than that of the Wolga! So that, according to this measurement, if there is any difference between the levels of the two seas, the Caspian is the higher! Address of Pres. Lyell to Geolog. Soc. and Lond. and Edin. Philos. Mag.

Effect of Forests upon the Temperature. A motion has been lately made in the Chamber of Deputies for the general clearing of the woods in France. M. Arago showed that the clearing of extensive woods may be attended with effects of various kinds—the climate may be affected in many ways. He proceeded:—"To form a mean temperature in a given climate, there may be a very unequal distribution in the monthly temperature: it is from hence that Buffon conceived the idea of distinguishing temperate climes, from excessive ones. The climate of North America is now severe—that of Europe was equally so before it was cleared of forests. At those early periods the winters were much colder, and the summers much warmer than at present. You will perhaps be surprised to hear that a few centuries ago the summer heat in the vicinity of Paris was much greater than it is in our own times. This is a fact, however, which is proved by various documents; among others, by a charter allowing the vine-growers of Amiens to compete with other districts of France, for the honor of supplying the most perfect wines to the table of Philip Augustus. I do not suppose that any vine-growers of Amiens, at the present day, would set up the pretension of being able to supply the best wine to any one.

"A very extensive modification has occurred in the climate of that region of France—it has been the necessary consequence of clearing the woods."

Lond. Jour. of Arts, April.

Progress of Civil Engineering.

Report of E. F. Gay, Engineer on the Columbia and Philadelphia Railway, upon Motive Power.

To the Board of Canal Commissioners of Pennsylvania:

GENTLEMEN—Having made report to the superintendent relative to the construction of works done, or contemplated to be done, on the railway, I proceed to comply with the further instructions of your secretary, by reporting to you the situation of the line, and the motive power upon it.

The superstructure of the railway has continued in an excellent condition during the past season; indeed, with the exception of the north track, on the eastern twenty-two miles of the road; (which is constructed chiefly of wood,) the permanent character of the railway is a sufficient guarantee that few repairs of importance will be required on it for many years to come. The substructure of the road is generally of a solid and substantial character; the viaducts are the only works which are liable to injury from the heavy travel over them. Three of the piers to the Little Conestoga viaduct, and one at Mill Creek, have been badly fractured, as they were defective in their original construction; they have, however, been properly secured with buttresses, and may now be considered in a safe condition. It is probable that one other pier at Mill Creek viaduct will require the support of buttresses in the course of another summer, which work the supervisor has included in his estimate for repairs. All the other viaducts are in a good condition. As the fears of the traveling community have been frequently expressed in relation to the danger of these viaducts taking fire from the sparks emitted from the chimneys of the locomotives, it may be proper for me to remark that little fear need be entertained of fire from such a cause; this may be inferred from the fact that the cool atmosphere in the viaduct condenses the steam as it escapes from the exhaust pipes, and so

moistens the surface exposed, as to prevent ignition from the sparks; indeed, so rapidly does the steam condense during very cold weather in winter, that the water falls in drops from the interior of the bridge roof. Coals have sometimes fallen from the ash-pan of the engine on the floor of the bridge; any danger, however, from this source, is obviated by a slight coating of gravel distributed over the exposed surface. Confidence, it is believed, may therefore be justly entertained, that so great a calamity as the destruction of one of these viaducts by fire need not be apprehended from the use of locomotive engines upon the road; yet it is by all means important that a watchful eye should continually be kept over them.

The inclined planes are, and have continued during the past season, in excellent condition. I am happy to state, that in the ordinary operation of ascending and descending the plane with the aid of the machinery, not a single accident of a serious nature has occurred during the past year. The operation of the planes is, however, always attended with more or less delay, particularly in damp weather when the adhesion of the rope is diminished, and the detensions which occur are exceedingly annoying to travellers, *the fault-finding part of whom*, without stopping to inquire the cause, do not hesitate loudly to attribute it to the mismanagement of the public agents. So much has been said about the construction of railways to avoid the Schuylkill and Columbia inclined planes, that I was last summer induced to make a cursory examination, with a view to ascertain the fall and distance from a point on the railway near the Spread Eagle crossing, in Radnor township, by way of the Gulf Valley to the Schuylkill, thence along the Schuylkill to the west end of the viaduct at the foot of the inclined plane. This distance is found to be fifteen and one quarter miles, (about two miles further than by the present railway,) and the fall three hundred and eighty-one feet, being at the rate of twenty-five feet per mile. I did not, however, trace the line over the ground upon which the railway would be located, neither did my limited time allow me to take any notes with a view to estimate the cost of a railway upon that route; but, from general observation, I am of opinion that the undulating character of a large portion of the line would render the grading of a railway upon it decidedly expensive; it is, however, by no means impracticable, and is certainly worthy of a more minute examination. At the request of the citizens of Columbia, I have also made an examination, with plans, estimates, &c., of a line of railway to avoid the Columbia inclined plane; this line commences near the village of Mount Pleasant, and, passing down the valley of Strickler's run, crosses the present railway near the foot of the inclined plane, at an elevation of about twenty feet above the track, and enters Front street, in which it was designed to be continued to the basin; the whole distance of five and one quarter miles being not more than one-third of a mile longer than the present line, and the graduation will not exceed thirty-four and a half feet per mile. The grade, however, can be reduced to thirty-three and one-third feet per mile, and a superior line be obtained, by keeping to the east of Front street after crossing the railway, and passing through what has been commonly termed the alley route, which will intersect the present railway on the east side of the basin, thereby affording additional facilities for the transaction of business. The grade, although higher than desirable, yet being within the limits of locomotive power, is deemed so much superior to the present arrangement, as to justify the opinion that the charge is well worthy being recommended to the serious consideration of the legisla-

ture. The estimated cost of this change, if the rails are removed from the present line, is $110,000; or, if laid with a new wooden track, $133,360.

Motive Power.

At the date of my last annual report, two locomotive engines, viz: the Lancaster and Columbia, were in successful operation upon the line, and thirteen others had been contracted for, the most of which were expected on the road early in the spring. This anticipation, however, was not realized, as but seven engines were in readiness to meet the demands of the spring trade, since which time the number has gradually increased to seventeen, viz: ten manufactured by M. W. Baldwin, Esq.; five by Robert Stevenson of England; one by Coleman Sellers & Sons; and one by Long & Norris, the latter two have been but recently put upon the road, and their capacity is not yet fairly tested; they are, however, believed to be excellent engines. The engines from Mr. Baldwin have all been tested, and found to be of the first class. The five engines imported from England, are not so efficient as those manufactured in this country; the workmanship of them is good, but many important parts of the machines are too light to enable them to encounter (with a heavy load) the higher grades and severe curves on this railway; in consequence of which, frequent repairs are required upon them. These engines were not obtained from England, (as has been generally supposed,) with the view of getting *better* engines than could be procured in this country, but simply because locomotives could not be manufactured here, fast enough to meet the wants of the road. My own opinion has always been in favour of encouraging the mechanics of our country in the manufacture of engines. Nothing but a suitable degree of encouragement is wanting to arouse the native enterprise of our mechanics to this important branch of business; and locomotive engines brought from England to this country for sale, will most assuredly find a *bad market*.

There are not at present a sufficient number of engines on the road to meet the current demands of the trade, as in consequence of repairs required, not more than two thirds of the number on the road can be kept in readiness for actual service. This deficiency will, however, be in a great measure diminished, whenever duplicates can be obtained for such parts of the engines as are most liable to injury, and workshops can be properly arranged to do the repairs without the loss of time. Indeed, the want of suitable workshops, during the past season, to do the repairs promptly, has materially lessened the amount of available power on the road. It may be asked, "Why these workshops were not built"? To this I can only reply, that it was last year contemplated to erect additions to the shop at Columbia, so as to do all the repairs at that end of the road; but before funds were provided for the prosecution of the plans proposed, the rapidly increasing trade on the road suggested the propriety of selecting a more central position on the line for their location. It was therefore, thought most prudent to defer the matter for a month or two, that the proper point might be more clearly indicated, by the running of the engines. After due consideration of all the advantages and disadvantages, which seemed to have a bearing on the subject, it was early in July decided to erect the workshops, necessary to do all the repairs upon the road, at Parkesburg, being the point selected for the junction of the Oxford railway and the state works. This position embraces many advantages: such as being very nearly central; it is healthy, and has an excellent spring of running water for the supply of the engines. It may be proper here to remark, that a donation of

all the ground required for the accommodation of the workshops, together with a lot for a collector's office, has been made to the commonwealth, by the owner, Mr. Parke. The depot and workshops are now finished, and in readiness for the reception of the tools, and machinery, which are in a state of preparation, and will probably be completed during the present month. It is to be regretted that the want of funds has not allowed the erection of the necessary dwellings, for the workmen connected with the shops, as boarding is difficult to be obtained in the vicinity, which will of course interfere with any system that may be adopted for the repairs, until an appropriation shall be made for the necessary buildings. When this is done, and the buildings completed, a proper degree of economy can be preserved in this important branch of the establishment. The engines upon this road have generally performed their trips with great regularity; and it affords me pleasure to add, that the American engines, delivered within the present year, are capable of doing more work than was estimated in my last report: the most of them, in their ordinary trips, draw a gross load of seventy-five tons. The engine Schuylkill has drawn over the road a gross load of *one hundred tons*, and several others have drawn, over the highest grade, from eighty to ninety tons gross. When the curves and grades upon this road are taken into consideration, it is believed that the performance of these engines will be found equal to any in America. It is also gratifying for me to be able to state, that most of the prejudice which existed along the line against the use of locomotive engines last year, appears to have vanished, and in its place has arisen a prepossession in their favor: this however, is nothing more than might reasonably have been expected, for certainly no intelligent individual can witness the performance of a single engine, drawing a train of fifteen cars, loaded with three tons each, from one inclined plane to another, (seventy-seven miles,) in eight hours, without honestly acknowledging the decided superiority of steam over horses—at least so far as its application to railways.

Of the twenty locomotives authorized to be obtained for this railway, seventeen (as has been previously stated) are upon the road, and the remaining three will probably be put on during the present month.

The cost of twenty engines, complete, will be -	$126,000
Average cost of each, - - - - -	6,300

As no separate account was kept, by the collectors, of the motive power received prior to the first of January last, and as all the expenses of that branch of the establishment were paid out of the construction fund up to the 1st of February, I am not able to furnish a comparison of the receipts and expenditures for motive power, previous to the latter date. The following statement will, therefore, exhibit its income and cost for nine months, commencing February 1st, and ending November 1st.

Amount received by collectors for motive power, -	$ 46,514 98
Expenditures and debt, (see supervisor's report,) - -	45,431 75
Excess of receipts over expenses, - -	$ 1,083 23
to this is added the excess of stock on hand over last year,	4,455 30
The actual excess over cost will stand, - -	$ 5,538 53
Or, if from the expenditures, - - - -	$ 45,431 75
Be deducted stock on hand over last year, -	4,455 30

The actual cost for motive power, for nine months, will stand, $40,976 45
Or, average cost per day, - - - - - 150 00

It is believed, that the receipts and expenditures of the ensuing year will be at least double the amount of the last year; but, as with the present tolls they would probably progress in nearly the same ratios, the preceding result will afford safe data to estimate the value of the motive power to the commonwealth. Taking, therefore, ten engines as the average number upon the road during the past season, the cost of which, at six thousand three hundred dollars each, would be sixty-three thousand dollars—

Interest of which is - - - - $ 3,150 00
Deduct above interest from surplus receipts and stock on hand, 5,538 53

Balance left towards refunding the principal, - $ 2,388 53

This, it is evident, will not be sufficient, as the durability of an engine will probably not exceed four, or, at furthest, five years, which would render an amount of fourteen thousand dollars per annum necessary to replace the engines, or about eleven thousand six hundred dollars more than the surplus of the present year, to each ten engines. It is believed, however, that a large portion of this amount would have been received during the past year, if all the tolls from passengers traveling on the road had been collected; but as this evidently had not been done, in order to remedy the evil, I would recommend that a careful and attentive agent of the commonwealth should be placed on each line of passenger cars, whose duty it shall be to keep a way-bill, in which he shall note the number of passengers in each car, and the distance traveled by them—and who shall also see that the conductors of each car, or train of cars, keep a like way-bill, upon which the names of all the passengers should be entered.—This plan, it is believed, would soon ensure an important increase to the revenues of the commonwealth. In order, however, to aid still further in obtaining a surplus fund for the renewal of the engines, I would suggest the propriety of increasing the toll, for motive power, on each passenger, to one cent per mile. This change would probably, in connexion with the appointment of agents to keep way-bills, ensure a sufficient revenue to meet all demands upon the road for motive power.

In the following estimate of the amount required for motive power, during the ensuing year, I have endeavored to include every expense that can be anticipated. It is still probable, however, that the rapidly increasing trade, on this great thoroughfare may require additional expenditures, which cannot, at this time, be foreseen, but which may be found absolutely necessary before, in the ordinary course of business, a second legislature could act upon them. It seems to me, therefore, highly important that some especial fund should be provided, by which (if necessary) the agents of the commonwealth could meet any extraordinary demand upon the motive power, such as the opening of other railways, which connect with the Columbia line, and which being in the progress of construction, would create.

Estimated amount required for the ensuing year.

Fifteen additional locomotive engines and tenders, at $6,400,	$96,000
One stationary engine for workshop, - - -	2,000
Tools, machinery, &c., for same, - - - -	4,000
Additional water stations, reservoirs, &c. - - -	1,800
Turn-outs, crossings, swivels, &c. - - - -	1,500
Sheds for night stands, at water stations, - - -	2,000

Additional set of ropes at inclined planes, - - -	3,000
	$110,000
If no arrangements should be made with a view of avoiding the planes, a second set of stationary engines will be required, which, with their erection, will cost, - - -	16,000
To which should be added the covering of the planes, recommended in my last report, - - - - -	25,000
Total,	$156,000

Having in previous reports expressed my opinion in relation to the manner of using this railway, I deem further remarks on that subject unnecessary. The cars being at present owned by individuals, are generally kept in good condition, and owners appear uniformly well disposed toward making such repairs, or alterations, as they are from time to time directed to make. * * * *

M. Brunel's mode of constructing arches without centering. The principle, which was originally adopted, and its efficacy ascertained, in the formation of the shaft of the Thames Tunnel, is founded upon the cohesive power of Roman cement, coupled with a system of ties, the most eligible substance for which, from a series of experiments performed by M. Brunel, appeared to be hoop iron. The piers having been constructed in the usual manner, it is proposed to pin, or secure, to them a mould for the purpose of determining the contour of the arch. A narrow rib may now be carried over, and keyed, using cement (with the occasional insertion of ties), which, by its adhesion to the brick being greater than the cohesion, enables the arch to be carried to any extent within the limits of the strength of the material. The several arches being in succession, once keyed, they will be in a state to receive the whole of the materials necessary to the completion of the bridge.

The bridge of the Santissima Trinitá at Florence was particularly adverted to, as affording a magnificent example of rubble construction, and the durability of the material. The arches are composed of a mass of irregular stones embedded in mortar, having the consistence of a single stone, or of two stones abutting against each other at the crown.

Lond. Archit. Mag., April.

Cast and Wrought-Iron Wheels.—It was stated at a meeting of the Institution of Civil Engineering, that where cast-iron wheels on rail-ways would only last six or eight months, wrought-iron would serve at the same work three or four years.

The wear of the Manchester and Liverpool line was stated to be 1-20th of an inch in depth per annum. The flanges rarely come into contact with the rails; one of the oldest wheels being taken off a carriage, the marks of the turning tool was found on the flange.

Lon. Mech. Mag.

Mechanics' Register.

INVENTION OF THE MARINER'S COMPASS.

The invention of this precious instrument has hitherto been awarded

to Favio Gioia, a Neapolitan, in 1302, or 1303. But this statement has rested on no satisfactory evidence; and, when it was discovered that the Chinese and Arabian authors had spoken of the magnet's polarity before the fourteenth century, it began to be suspected that the Neapolitan was merely the introducer of the compass into Europe. To settle the question, in January, 1834, Baron Humboldt wrote to M. Klaproth to ascertain the epochs,—1st. When the Chinese discovered the polarity of the magnet; and, 2d. When they began to apply it to the purposes of navigation. M. Klaproth has replied in a work, published in Paris towards the close of the year, in which the most remarkable proof of the Chinese claims to this invention, is in the history of the magnetic chariots, whose origin is lost in the obscurity of the mythological ages. The accompanying representation of one of these chariots is taken from the 33d volume of *Japanese Encyclopædia.*

The figure in front of the chariot was made of some light material; it was fixed upon a pivot, and its finger invariably pointed to the south, which, as we have already said, was the *kibleh*, or sacred point of the Chinese, to which they always turn when performing their devotions. It is intimated rather obscurely, that these magnetic chariots were first invented for a religious purpose, namely, to enable the devout to discover their *kibleh* when the sun and stars were obscured by clouds—a purpose to which the compass is frequently applied in the present day by Mohammedan nations; but there are very full descriptions of the use made of these chariots in directing the march of armies, and guiding ambassadors. M. Klaproth has collected, from Chinese authorities, many curious anecdotes of the use made of these chariots; under the Tsin dynasty they formed a part of every royal procession.

(Magnetic Charlot.)

In the *Tsin-tchi*, or history of that dynasty, we find—"The wooden figure placed on the magnetic car resembled a genius wearing a dress made of feathers; whatever was the position of the car, the hand of the genius always pointed to the south. When the emperor went in state, one of these cars headed the procession, and served to indicate the cardinal points."

In the history of the second Tchoa dynasty, which lasted from A. D. 319 to A. D. 351, we read,—"The Chang Fang (president of the board of works) ordered Kiai Fei, who was distinguished by his great skill in constructing every kind of instrument, to build a number of magnetic chariots, which were sent as presents to the principal grandees of the empire." There are several accounts of the manner in which the magnetic figures were constructed: as our readers have probably anticipated, a magnetized bar passed through the arm of the figure; and the only

variety of ingenuity displayed by the architects was in balancing the figure upon its pivot.

The antiquity of these magnetic chariots is established incontrovertibly; the step from them to the compass is so very easy, that we may safely assert that the one must have led immediately to the other.*

Arcana of Science for 1835.

The Bude Light is a name given by M. Gurney (of steam carriage abortion celebrity) to a new light which he has discovered, and so named, after his new place of residence in Cornwall. It is obtained by directing a stream of oxy-hydrogen gas on a quantity of pounded egg-shells.

Mech. Mag.

Query. In what does this differ from the well known light by a stream of wind, oxygen and hydrogen gases, on lime? The egg-shells will first be reduced from the state of a carbonate to nearly pure lime.

The Freyberg Suspension-Bridge.—We regret to learn, from a friend who has just returned from Switzerland, that, in consequence of some symptoms of insecurity exhibited by the suspension-bridge at Freyberg, the local authorities have ordered it to be stopped up for the present. Ib.

Paving with Wood.—The editor of the London Architectural Magazine, makes the following statement in relation to wooden pavements in Russia.—

The trunks of trees, from 9 in. to 1 ft. in diameter, are cut into lengths of from 12 in. to 18 in., deprived of their outside or sap wood, then squared, and afterwards set on end as common paving stones are in London. The courts of the larger mansions in Petersburg, Moscow, and Vienna are frequently paved in this manner, not for the sake of durability, nor for any reasons of economy, but simply to lessen the noise made by the wheels of carriages, when coming to set down or take up company.

Lond. Arch. Mag.

The Bell Rock Light-House has suffered greater damage during the severe gales of the last autumn and winter than at any time since its erection. The spring tides in January rose to 116 feet, and drifted over the building; while, on ordinary tides, 19 feet is the extent of their rise. The heaviest ground-swell preceded the heaviest wind by two days. Some large rocks, called "travellers," were thrown up against the foundation of the light-houses, weighing about five tons! Lond. Mech. Mag.

Drilling Holes in Glass.—A method of boring glass with a drill dipped in spirits of turpentine, has been introduced from Paris. A bow and steel drill kept moist with the spirit, rapidly drills a smooth hole through glass of any thickness; I have drilled a hole through the thick bottom of a tumbler with a broken triangular file in a very short time. The drill is not blunted more than it would be by piercing iron of the same thickness.

A. Trevelyan, in Lond. Mech. Mag.

Iron Steam Boat.—The Alburkha was built at Liverpool by Messrs. M'Gregor, Laird, & Co. Her dimensions are—"Length 70 feet; beam, 13 feet; depth, 6 feet 6 inches; tonnage, including engine-room, 56; draught of water, with engine, coals, and water in boiler, 2 feet 9 inches; with provisions, water, &c., for her voyage to the Niger, 4 feet 6 inches. The bottom and sides of this vessel are composed of iron plates, the former, five-sixteenths of an inch thick, the latter, a quarter of an inch: engine fifteen horse power. All accounts that have been received from this vessel, agree that she is much *cooler* and *drier*, and, of course, more healthy, than a vessel built of wood; that she is an excellent *sea* boat."

Nautical Magazine, vol. II. p. 678, and Arcana of Science for 1835.

List of American Patents which issued in April, 1836.

		April.
274.	*Cutting saw teeth.*—Samuel G. Merriman, Southington, Conn.	11
275.	*Furnace for smelting.*—Arundius Tiers, Kensington, Penn.	11
276.	*Boats and rafts, passing, &c.*—Benning Sanborn, Lyman, N. Hampshire,	11
277.	*Corn and cotton planter.*—George C. Boyd, New London, Penn.	11
278.	*Soda Fountains.*—R. Boston and T. Bryan, N. York,	11
279.	*Saw mill.*—Daniel Gerrish, Boston, Mass.	11
280.	*Saw mill blocks.*—Erastus Rathburn, Coneaut, Ohio,	11
281.	*Bake oven.*—Eben B. Strong, Buffaloe, N. Y.	11
282.	*Water wheels, &c. for mills.*—John T. Towne, Mount Morris, N. Y.	11
283.	*Serving ropes.*—Charles Parke, N. Y.	13
284.	*Sacking bottom, &c.*—L. L. Wells, Middletown, Conn.	13
285.	*Brick machine.*—Nathaniel Adams, Newburg, N. Y.	13
286.	*Hats, napping, &c.*—L. Lyon, 2nd. Needham, Mass.	13
287.	*Coffee mills.*—C. W. Peckham, New Haven, Conn.	13
288.	*Door lock.*—Benjamin Smith, Canton, Conn.	13
289.	*Cotton seed huller.*—Peirson Reading, Trenton, N. J.	13
290.	*Cotton gin.*—Peirson Reading, Trenton, N. J.	13
291.	*Mortising and boring machine.*—George Page, Keene, N. H.	13
292.	*Cooking stove.*—Charles Vale, Newark, N. J.	13
293.	*Hydrostatic press.*—Thomas Baxter, Petersburg, Va.	13
294.	*Bed, spiral spring.*—M. T. Moody, and B. Eastman, Northampton, Mass.	13
295.	*Pistols.*—Bond B. M. Darling, Billingham, Mass.	13
296.	*Spark Extinguisher.*—James F. Curtis, Boston, Mass.	13
297.	*Mortising timber.*—George Page, Keene, N. H.	21
298.	*Glass cases.*—Thomas W. Whitty, Patterson, N. J.	21
299.	*Brick machine.*—Gooding Halloway, Montgomery county, Penn.	21
300.	*Corn husks, slitting.*—Asa Bonett, Baltimore, Md.	21
301.	*Churn.*—Charles Merriman, Middletown, Conn.	21
302.	*Washing machine.*—Charles Merriman, Middletown, Conn.	21
303.	*Stove for carriages.*—Alexander McWilliams, Washington city,	21
304.	*Washing machine.*—Henry Souder, Strasburg, Penn.	21
305.	*Harrow.*—J. C. Conklin, Peekskill, N. Y.	21
306.	*Shingles, dressing.*—N. P. Hawk and J. Keyes, Union, N. Y.	21
307.	*Sawing wood.*—Jos. Pinneo, Jr. Hanover, N. H.	21
308.	*Ice cutting machine.*—Samuel Trask, Hallowell, Maine,	21
309.	*Straw cutter.*—James M. Wolfolk, Oldham co., Ken.	21
310.	*Plough.*—John Farlee, Mercer co., Ken.	21
311.	*Ores and sweepings, washing.*—William Davis, city of N. Y.	28
312.	*Paddles for boats.*—John Cochran, Baltimore, Md.	28
313.	*Bedstead fastenings.*—John McLaughlin, Sunderland, Vt.	28
314.	*Thrashing machine.*—Hugh Barclay, Lexington, Va.	28
315.	*Saw mill.*—James Sanders, Alleghany co., Md.	28
316.	*Stoves.*—Frazier H. Blanchard and B. Gill, N. Y.	28
317.	*Cotton, condensing.*—Arlon Mann, Smithfield, R. I.	28
318.	*Spring saddle.*—Peter Crim, Waynetown, Penn.	28
319.	*Cooking stove.*—Jonas Kendall, Ipswich, Mass.	28
320.	*Excavating from rivers, &c.*—Silvanus Russel, Baffalo, N. Y.	28
321.	*Smut machine.*—William B. Ryan, Mount Morris, N. Y.	28
322.	*Window blind fastenings.*—Jonathan Bacon, Bedford, Mass.	28
323.	*Carriage wheels, confining.*—Clark Force, Baltimore, Md.	28
324.	*Rail road cars.*—Isaac Knight, Baltimore, Md.	28
325.	*Lath machine.*—Elihu Smith, Ithaca, N. Y.	28
326.	*Gimblets.*—William M. Fowler, N. Branford, Conn.	28
327.	*Boxes, fitting to wheels.*—J. and C. Putnam, Hallowhill, Maine,	28
328.	*Shears for tailors, &c.*—Richard Fitzgerald, Elizabethtown, N. J.	28
329.	*Stoves.*—Frederick Frickhards, Easton, Penn.	28
330.	*Leather rolling machine.*—J. McLaughling and H. Hill, Sunderland, Vt.	28
331.	*Plough.*—Nathan Locklin, Sparta, N. Y.	28

CELESTIAL PHENOMENA, FOR AUGUST, 1836.

Calculated by S. C. Walker.

Day.	H'r.	Min.				
5	13	2	v' Tauri	,5,	119°	68°
5	14	1			288	233
5	13	38	v^2 Tauri	,6,	138	85
5	14	34			270	215
22	10	2	τ Sagittarii	,4,	123	157
22	11	11			258	285

Meteorological Observations for April, 1836.

Days.	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rise.	Barometer. 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
	☉	☽	⊗	☾	☉	☽		
							Inches.	
1	32°	41°	Inches 30.10	Inches 30.05	E. SW.	Moderate.		Lightly cloudy—drizzle.
2	38	54	29.90	29.85	SW.	do.		Cloudy—clear.
3	39	59	29.80	29.80	NW.	Brs ge.		Clear day.
4	43	43	29.73	29.13	NW. NE.	Moderate.		Cloudy—drizzle.
5	36	59	29.76	29.84	NW.	do.		Clear day.
6	39	56	29.95	29.95	N.	Breeze.		Cloudy day.
7	27	52	30.10	30.14	WSW.	do.		Clear day.
8	31	54	30.10	30.10	SW. S.	Brisk.		Clear—cloudy.
9	55	72	29.84	29.75	E. W.	Cloudy—lightly cloudy.		
10	55	47	29.66	29.66	S. W.	Blustering	.15	Rain—flying clouds.
11	27	39	30.00	30.05	W.	do.		Clear—frost—flying clouds.
12	26	50	30.30	30.34	E. SE.	Moderate.		Clear day
13	31	43	30.30	29.90	SE.	do.	1.85	Cloudy—flurry of snow—rain.
14	41	55	29.52	29.55	W.	do.	.8	Clear—flying clouds—shower.
15	35	49	29.75	29.75	W.	do.		Partinly cloudy—flying clouds.
16	35	55	30.03	30.11	W. SW	do.		Clear day.
17	35	56	30.15	30.20	E. SSE.	do.		Cloudy—partially cloudy.
18	46	61	29.95	29.86	SE. SSE.	do.	.16	Cloudy—rain.
19	51	50	30.00	30.10	N. E.	do.	.14	Rain—rain
20	46	62	30.15	30.24	NE. SW.	do.		Cloudy—clear.
21	47	61	30.04	29.84	E. S.	do.	.2	Drizzle—lightly cloudy—rain.
22	38	48	29.84	30 0	W.	do.	.15	Clear do. brilliant aurora B.
23	40	57	30.10	30.30	S. NW. W.	Blustering		Cloudy—flying clouds.
24	44	57	30.10	30.30	NW. W.	do.		Lightly cloudy—clear.
25	34	61	30.40	30.36	NE. SW.	Blustering.		Clear day.
26	48	70	30.02	29.82	E. W.	do.		Cloudy—hazy.
27	60	71	29.96	29.96	NW. W.	do.		Clear day.
28	49	74	30.30	30.20	NE. S.	do.		Clear—lightly cloudy.
29	56	71	30.10	30.00	SE. S.	do.		Cloudy—lightly cloudy.
30	59	54	30.10	30.20	E.	do.		Cloudy—drizzle.
Mean	40.90	55.30	29.96	29.97			2.65	

	Thermometer.	Barometer.
Maximum height during the month,	76. on 26th.	30.40 on 25th.
Minimum do.	26. on 12th.	29.13 on 4th.
Mean do.	48.10	29.965